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ABSTRACT

This book presents a study of high school mathematics and science in six states, 12 districts, and 18 schools. The study is an effort to document state, district, and school policy and practices and the enacted curriculum as provided by teachers and experienced by students. The data consist of daily records of instructional practices for 62 teachers, 116 observations of 75 teachers, 81 teacher interviews, 312 teacher questionnaires, 76 school administrator interviews, 44 district administrator interviews, and 18 interviews of education agency administrators. Among the conclusions are that the study took place in a time of great transition, many state and district policies are weak but they can have strong effects, and textbooks and tests are important instructional resources that can and often do influence the nature of high school mathematics and science instruction. (PR)

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October 1993

Reform Up Close: An Analysis of High School Mathematics and Science Classrooms

**Andrew C. Porter, Michael W. Kirst,
Eric J. Osthoff, John L. Smithson,
and Steven A. Schneider**

Final Report to the National Science Foundation on Grant No. SPA-8953446 to the Consortium for Policy Research in Education

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REFORM UP CLOSE: AN ANALYSIS OF HIGH SCHOOL MATHEMATICS AND SCIENCE CLASSROOMS

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Wisconsin Center for Education Research
School of Education
University of Wisconsin
Madison, Wisconsin

October 1993

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ABSTRACT

Reform Up Close is a study of high school mathematics and science in six states, 12 districts, and 18 schools. Data were collected in 1990 and 1991, a point in time well after the first round of state and district standard setting following *A Nation At Risk* (1983). The study represents a comprehensive effort to document, on the one hand, state, district, and school policies and practices concerning mathematics and science instruction and, on the other hand, the enacted curriculum as provided by teachers and experienced by students.

The motivations for the study were several. First and foremost, the study sought to determine whether math and science curricula were being compromised by increased enrollments due to increased high school graduation requirements. An early hypothesis was that increased high school graduation requirements would result in increased dropouts. When that did not occur, it was hypothesized that courses would be compromised to accommodate increased numbers of weaker students. In addition to this primary motivation, the study sought to describe the nature of state, district, and school curriculum policymaking as it applies to high school science and mathematics. Because the study required detailed descriptions of content and pedagogical practices as they occurred in high school mathematics and science courses across the country, the study served yet a third purpose of providing baseline data against which the ambitions of the late 1980s curriculum reforms could be judged. A fourth purpose of the study was to determine the relationship between curriculum policy characteristics and classroom practice. While it was not a motivating factor for the study, there is yet a fifth aspect of the work of major significance. To describe the enacted curriculum, methodological advances were necessary in procedures for describing opportunity to learn. As interest in school process indicators has increased in recent years, efforts to define and measure opportunity to learn have also increased. The methods developed here appear quite promising.

Data for the study can be thought of in terms of four levels. There were state level interviews of key individuals at the state education agency to learn of state initiatives relative to standard setting in high school mathematics and science. At the district level, there were interviews to determine administrators' understandings of state initiatives and how they are passed on to schools, as well as district initiatives aimed at upgrading math and science curricula. The school level data came in two forms: interviews of school administrators to learn of math and science practices in the school, and a questionnaire survey of all mathematics and science teachers in each participating high school. Data on classroom practices were obtained from both the teacher survey and the target sample of four courses per school. Target sample data were collected through teacher interviews, daily logs describing the content and pedagogy of instruction, and weekly questionnaires describing special instructional and professional activities in which teachers participated. A prelog survey was used to obtain basic demographic information. All target sample teachers were observed at least once (and usually twice) teaching the target class.

The data set is large, rich, and complex, consisting of daily records of instructional practices in target courses for 62 teachers, 116 observations of 75 target teachers, 81 target teacher interviews, 312 mathematics and science teacher questionnaires, 76 school administrator interviews, 44 district administrator interviews, and 18 interviews of education agency administrators.

A great deal of detailed information about high school mathematics and science is contained in this report. The information ranges from detailed descriptions of instructional practices, on the one hand, to detailed descriptions of state curriculum policy initiatives, on the other. Readers will bring to the report their individual interests. From the authors' perspective, however, there are five especially noteworthy results.

First, the data are largely positive on the influence of state, district, and school standard setting activities. As a result of increased standards (e.g., increases in the number of credits of mathematics and science required for high school graduation, increases in university entrance requirements in mathematics and science, district and school steps to eliminate remedial courses in mathematics and science, and district and school efforts to have all students take at least beginning level college preparatory coursework in math and science), more high school students are receiving more worthwhile math and science instruction than ever before. Especially to the point of this study, increased enrollments in math and science courses do not appear to have compromised the curriculum of those courses.

A second highlight of the report is the rich descriptions of classroom practice. Teacher logs of instructional practices, recorded daily, collected weekly, and aggregated over a full school year of instruction, provide an unusually detailed and complete description of content and pedagogical practices of high school mathematics and science. At least for the math and science course sections in our study, the enacted curriculum in high school mathematics and science was not at all in alignment with the NCTM *Curriculum Standards* or the AAAS *Science for All Americans* standards. In mathematics, there were far too many remedial and basic courses, with essentially arithmetic as the content. Statistics, probability, and discrete mathematics, content areas emphasized in the new standards, received virtually no attention in any of the courses studied including advanced courses. All math courses reflected a heavy emphasis on exposition and equations and little emphasis on modelling, real world problems, and data collection. The emphasis remained heavily on memorization and computation. In science, the picture was similar. Science courses made little to no use of field work. Nearly half of the science courses allocated less than 5 percent of instructional time for lab work, and approximately half of the courses studied allocated less than 10 percent of instructional time to collecting data. Instead, the emphasis was heavily on memorizing facts and understanding concepts through lecture and textbook presentation.

A third highlight of the report is found in the comprehensive descriptions of state, district, and school curriculum policymaking. In 1990 and 1991, curriculum policymaking had not yet taken on the coherence implied by systemic reform. None of the six states and 18 districts had anything like a comprehensive approach to supporting the ambitious reforms reflected in the NCTM *Curriculum Standards* and AAAS's *Science for All Americans*. California and Arizona were furthest along, in that both states had moved away from the minimum competency basic skills frameworks of the 1970s to adopt new curriculum frameworks calling for ambitious content for all students. But at the time of the study, neither state had in place assessment programs consistent with their frameworks. In contrast, Florida and South Carolina had not yet rejected the minimum competency basic skills agenda, and Pennsylvania and Missouri had done relatively little to provide curriculum leadership of any kind.

Our case study of curriculum leadership in South Carolina is a fourth highlight of the report. While South Carolina remained largely committed to a minimum competency basic skills curriculum, South Carolina was the one state which had a comprehensive and coherent approach to curriculum leadership. As in the other states, however, much greater attention was given to mathematics than to science. The curriculum policies described in our South Carolina case study are those developed during the period in which Richard Riley was Governor. While many will disagree with the objective of minimum competency basic skills, the South Carolina approach is impressive in its comprehensiveness and its coordination across levels of the education hierarchy.

Yet a fifth highlight of our work is methodological. The taxonomies we developed for describing high school mathematics and science curricula represent good examples of much needed languages for communicating the content and pedagogy of practice. Teachers need such languages to talk among themselves about their intentions and their successes. Education administrators need such languages for monitoring the enacted curriculum, making sure that instruction is consistent with intentions and equitably distributed. Policymakers need such languages for communicating the intended curriculum.

The daily logs and the questionnaires in the study represent two approaches that might be used for creating indicators of opportunity to learn. At the national level, school delivery standards and opportunity to learn standards are receiving a great deal of attention. A large part of the interest in such standards is stimulated by a concern for equity. If students are to be held to high standards of achievement, then schools must provide students with a fair opportunity to learn. Regardless of how controversy over school delivery standards is resolved, it seems likely that a system of school process indicators, including especially indicators of opportunity to learn, will result. To our knowledge, our validity studies of teacher log data against classroom observations and questionnaire data against teacher log data are the only validation results available for procedures that describe opportunity to learn. The validation results were very encouraging. Teacher logs represent an excellent technique where precise descriptions of opportunity to learn are needed. The questionnaire approach holds great promise as an economical description of opportunity to learn where larger samples of classes are needed.

CONTENTS

Chapter *Page*

1 STANDARD SETTING AND THE REFORM OF HIGH SCHOOL MATHEMATICS AND SCIENCE 1-1

Forward and Backward Mapping 1-5

The Study Design 1-7

The Timing of Our Study: Setting the Policy Context 1-9

Previewing the Report 1-12

Highlights 1-15

2 DESIGN, INSTRUMENTATION, AND VARIABLE CONSTRUCTION 2-1

Design 2-1

Selecting States 2-2

Selecting Districts and Schools 2-5

Selecting Courses 2-6

Phase I 2-6

Phase II 2-8

Selecting Teachers 2-10

Sample Characteristics 2-11

Instruments 2-12

Logs 2-13

Taxonomies of mathematics and science content 2-14

Log procedures 2-18

Quality of log data 2-21

Classroom Observations 2-22

Chapter *Page*

2 Questionnaire 2-26

Student Outcome Data 2-32

School Level Interviews 2-33

  Teacher interviews 2-33

  Department chair interviews 2-34

  School counselor interviews 2-34

  Principal interviews 2-34

District Level Interviews 2-35

  Assistant superintendent for curriculum interviews 2-35

  Math and science specialist interviews 2-35

  Testing director interviews 2-35

State Level Interviews 2-36

Variable Construction 2-37

Scales Based on Questionnaire Data 2-37

Scales Based on Log Data 2-41

Course Descriptors 2-43

Identification and Demographic Variables 2-44

3 MATH AND SCIENCE CURRICULUM UPGRADING POLICIES AND PRACTICES AT THE STATE, DISTRICT, AND SCHOOL LEVEL 3-1

Arizona 3-2

Arizona - Large Urban District 3-4

Arizona - Large Urban School (A1) 3-10

Arizona - Large Urban School (A2) 3-15

Chapter *Page*

3 Arizona - Smaller Rural District 3-20
Arizona - Smaller Rural School (A3) 3-22
California 3-26
California - Large Urban District 3-30
California - Large Urban School (C1) 3-36
California - Large Urban School (C2) 3-38
California - Smaller Rural District 3-42
California - Smaller Rural District (C3) 3-44
Florida 3-48
Florida - Large Urban District 3-51
Florida - Large Urban School (F1) 3-54
Florida - Large Urban School (F2) 3-57
Florida - Smaller Rural District 3-63
Florida - Smaller Rural School (F3) 3-65
Missouri 3-68
Missouri - Large Urban District 3-71
Missouri - Large Urban School (M1) 3-80
Missouri - Large Urban School (M2) 3-85
Missouri - Smaller Rural District 3-88
Missouri - Smaller Suburban School (M3) 3-92
Pennsylvania 3-96
Pennsylvania - Large Urban District 3-98
Pennsylvania - Large Urban School (P1) 3-100

Chapter *Page*

3 Pennsylvania - Large Urban School (P2) 3-104

Pennsylvania - Smaller Rural District 3-105

Pennsylvania - Smaller Urban School (P3) 3-107

South Carolina 3-109

South Carolina - Large Urban District 3-113

South Carolina - Large Urban School (S1) 3-116

South Carolina - Large Urban School (S2) 3-120

South Carolina - Smaller Rural District 3-124

South Carolina - Smaller Rural School (S3) 3-128

Conclusions 3-132

Increasing High School Graduation Requirements 3-132

Curriculum Frameworks 3-134

State Testing 3-135

Other State Standard Setting and Curriculum Upgrading Initiatives 3-138

Reactions to State Initiatives 3-141

District Responses 3-141

School Responses 3-144

4 STATE AND DISTRICT POLICY CONTEXT AND SCHOOL RESPONSE: A SOUTH CAROLINA CASE STUDY 4-1

Part I: State Policies Affecting Math and Science 4-3

Education Improvement Act 4-3

The Basic Skills Assessment Program 4-4

The School Improvement Reward Program 4-8

Chapter Page

4 The Teacher Incentive Program 4-12
Sanctions in EIA Policy 4-15
Other Aspects of the EIA Initiative 4-16
Other Salient State Policies 4-20
State Graduation Requirements 4-20
State Curriculum Frameworks 4-22
Textbook Adoption 4-23
Teacher Certification 4-23
Professional Development 4-24
Summary of South Carolina State Policies 4-25
Part II: District Policies in South Carolina 4-26
Key Policies in District A 4-27
District Endorsement of State Policy 4-27
District Extension of State Policy 4-29
District Modification of State Policy 4-36
Independent District Initiatives 4-38
Summary of Key Policies in District A 4-39
Key Policies in District B 4-40
District Endorsement of State Policy 4-40
District Modification of State Policy 4-42
District Extension of State Policy 4-45
Independent District Initiatives 4-47
Summary of Key Policies in District B 4-48

Chapter Page

4 **Part III: District A's S1 High** 4-49

Students 4-50

Faculty 4-53

Administration 4-54

Math Department 4-56

Departmental Organization and Operation 4-58

Science Department 4-60

Departmental Organization and Operation 4-63

Instructional Resources 4-65

Math and Science Curricular Control 4-67

Textbooks and Curriculum Guides 4-67

State and District Tests 4-69

Professional Development and Evaluation 4-71

Other Curricular Influences 4-73

Course Sequences in Math and Science 4-74

Course Selection Process 4-75

Course Selection Criteria 4-76

Distinctive School Practices 4-77

Part IV: District A's S2 High 4-82

Students 4-83

Faculty 4-85

Administration 4-86

Math Department 4-89

Chapter *Page*

4 Science Department 4-90

Departmental Organization and Operation 4-91

Instructional Resources 4-93

Math and Science Curricular Control 4-94

Textbooks and Curriculum Guides 4-94

State and District Tests 4-94

Professional Development and Evaluation 4-97

Teacher Evaluation 4-98

Course Sequences in Math and Science 4-98

Course Selection Process 4-99

Course Selection Criteria 4-100

Distinctive School Practices 4-100

Part V: District B's S3 High 4-109

Students 4-110

Faculty 4-111

Administration 4-113

Math Department 4-114

Science Department 4-117

Instructional Resources 4-119

Math and Science Curricular Control 4-122

Textbooks 4-122

State and District Tests 4-124

Professional Development 4-126

Chapter *Page*

4 Teacher Evaluation 4-128

Other Curricular Influences 4-131

Course Sequences in Math and Science 4-131

Course Selection Process 4-132

Course Selection Criteria 4-133

Distinctive School Practices 4-137

5 CLASSROOM PRACTICE: THE ENACTED CURRICULUM IN HIGH SCHOOL MATHEMATICS AND SCIENCE COURSES 5-1

The Content of High School Mathematics and Science 5-2

Mathematics 5-2

Mathematical topics; Dimensions A and B 5-2

The questionnaire sample 5-9

Required courses and Math A as described by Dimensions A and B 5-12

Dimension C, mode of presentation 5-15

Required courses and Math A as described on Dimension C 5-16

Dimension D, expected learner outcomes 5-17

Required courses and Math A as described in Dimension D 5-21

Science 5-22

Science topics: Dimensions A and B 5-22

The questionnaire sample 5-31

Required science courses as described by Dimensions A and B 5-34

Dimension C, mode of presentation 5-36

Chapter *Page*

5 Required courses as described on Dimension C 5-38

Dimension D expected learner outcomes 5-40

Required science courses described by Dimension D 5-45

Mathematics/Science Comparisons 5-46

The Pedagogy of High School Mathematics and Science 5-47

Depth and Breadth of Coverage 5-48

Noninstructional Time 5-51

Modes of Instruction 5-53

Student Activities 5-54

Instructional Materials and Homework 5-56

6 EXPLAINING CLASSROOM PRACTICE: WHO TEACHES WHAT MATHEMATICS AND SCIENCE CONTENT TO WHOM 6-1

Variable Definitions 6-5

Control Variables 6-5

School Climate Variables 6-7

Teacher Climate Variables 6-10

Dependent Variables 6-11

Questionnaire Sample Regressions 6-12

Predicting Climate Variables 6-13

Group as a predictor 6-13

Policy as a predictor 6-19

States as predictors 6-20

Chapter *Page*

6 Predicting Classroom Practices 6-25
Group as a predictor 6-26
Policy as a predictor 6-39
States as predictors 6-40
Log Sample Regressions 6-43
Predicting Climate Variables 6-43
Group as a predictor 6-44
Policy as a predictor 6-44
Predicting Classroom Practices 6-44
Group as a predictor 6-45
Policy as a predictor 6-51

7 SUMMARY AND CONCLUSIONS 7-1
Design and Sample 7-2
Methodological Advances in Defining and Measuring Opportunity to Learn . . 7-3
The Curriculum Policy Landscape 7-6
What Did Curriculum Policy Look Like in 1990? 7-7
Standard Setting at the Top, Too 7-14
Promising Practices 7-15
A Special High School 7-16
California Math A 7-21
Disappointments 7-26
The Enacted Curriculum in High School Mathematics and Science 7-30
The Influence of Increased Enrollments in Mathematics and Science on Student Opportunity to Learn 7-31

Chapter *Page*

7 Professional Standards and the Enacted Curriculum in High School Mathematics and Science 7-38

Policy and Other Predictors of Classroom Content and Pedagogy 7-43

Policy 7-44

Subject 7-45

School Climate Variables 7-46

Class Characteristics 7-47

Teacher Characteristics 7-48

Predicting Curriculum Reform Implementation 7-50

Predicting School, Class, and Teacher Variables 7-51

Policy 7-51

Subject 7-52

Course Level 7-53

School Ability, School Behavior, and Class Ability 7-53

References

Appendix A DATA COLLECTION Instruments

Daily Log Form
Weekly Questionnaire
PreLog Survey
Training Manual
Classroom Observation Scales
Classroom Observation Outline for Notes
Math/Science Teacher Interview Protocol
Department Chair Interview Protocol
Counselor Interview Protocol
Principal/Vice Principal Interview Protocol
Assistant Superintendent of Curriculum Interview Protocol
Math/Science Curriculum Specialist Interview Protocol
Director of Testing Interview Protocol
State Math or Science Coordinator of Curriculum Interview Protocol

LIST OF TABLES

Table *Chapter 2*

2.1 High School Graduation Requirements

2.2 Target Courses and the Final Sample of Courses

2.3 Enrollment Data, Number of Sections Offered, for South Carolina Target Courses

2.4 Enrollment Data, Number of Sections Offered, for Arizona Target Courses

2.5 Sample Characteristics

2.6 Agreement Between Classroom Observations and Teacher Log Data on Content

2.7 Agreement Between Classroom Observations and Teacher Log Data on Pedagogy

2.8 Questionnaire Response Rate

2.9 Correlations Between Questionnaire and Log Data on Content Dimension A: Math

2.10 Correlations Between Questionnaire and Log Data on Content Dimension A: Science

2.11 Correlations Between Questionnaire and Log Data on Content Dimension D

2.12 Questionnaire Sample Student Ability Factor Matrix

2.13 Target Sample Student Ability Factor Matrix

2.14 Conversion of Emphasis Codes to Percent of Instructional Time

2.15 Questionnaire and Target Sample Distributions by Course Level and Course Type

Chapter 5

5.1 Content Variations Within and Between Course Titles: Math Dimension A

5.2 Dimension A Means and Standard Deviations by Course Type for Math Courses

5.3 Questionnaire Sample Means and Standard Deviations by Course Type for Math Courses

5.4 Algebra 1 Courses Required of All Students: Algebra Dimension B Content Emphasis Comparisons

Table

5.5 Content Variations Within and Between Course Titles: Math Dimension C

5.6 Dimension C Means and Standard Deviations by Course Type for Math Courses

5.7 Content Variations Within and Between Course Titles: Math Dimension D

5.8 Dimension D Means and Standard Deviations by Course Type for Math Courses

5.9 Questionnaire Sample Expected Student Outcomes: Means and Standard Deviations by Course Type for Math Courses

5.10 Content Variations Within and Between Course Titles: Science Dimension A

5.11 Dimension A Means and Standard Deviations by Course Type for Science Courses

5.12 Comparison of Chemistry Content in General Science, Physical Science, and Chemistry Courses

5.13 Questionnaire Sample Means and Standard Deviations by Course Type for Science Courses

5.14 Freshman Chemistry/Physics Course Required of All Students: Chemistry Dimension B Comparisons

5.15 Freshman Chemistry/Physics Course Required of All Students: Physics Dimension B Comparisons

5.16 Freshman Chemistry/Physics Courses Required of All Students: General Science Dimension B Comparisons

5.17 Content Variations Within and Between Course Titles: Science Dimension C

5.18 Dimension C Means and Standard Deviations by Course Type for Science Courses

5.19 Content Variations Within and Between Course Titles: Science Dimension D

5.20 Dimension D Means and Standard Deviations by Course Type for Science Courses

5.21 Questionnaire Sample Expected Student Outcomes Means and Standard Deviations by Course Type for Science Courses

5.22 Instructional Strategies and Expected Student Outcomes Means and Standard Deviations by Subject

5.23 Depth and Breadth of Coverage by Subject and Course Type

Table

5.24 Minutes of Noninstructional Time Per Class Period by Subject and Course Type

5.25 Modes of Instruction Means and Standard Deviations

5.26 Student Activity Means and Standard Deviations

5.27 Instructional Materials and Homework Means and Standard Deviations

Chapter 6

6.1 Questionnaire Sample Multiple Correlation Significance Levels: Policy Variable and Controls Only

6.2 Total Questionnaire Sample Regressions: Group and Control Variables to Predict School and Class Climate Variables

6.3 Total Questionnaire Sample Regressions: Group and Control Variables to Predict Teacher Climate Variables

6.4 Math and Science Questionnaire Sample Regressions: Group and Control Variables to Predict Teacher and Class Climate Variables

6.5 Total Questionnaire Sample Regressions: Policy and Control Variables to Predict School and Class Climate Variables

6.6 Total Questionnaire Sample Regressions: Policy and Control Variables to Predict Teacher Climate Variables

6.7 Total Questionnaire Sample Regressions: States and Controls to Predict School and Class Climate Variables

6.8 Total Questionnaire Sample Regressions: States and Controls to Predict Teacher Climate Variables

6.9 Math and Science Questionnaire Sample Regressions: States and Controls to Predict Climate Variables

6.10 Questionnaire Sample Multiple Correlation Significance Levels: Policy Variable, Controls, and Climate Variables

6.11 Total Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Pedagogy and Content

6.12 Total Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Content Dimension D

Table

6.13 Math Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Pedagogy

6.14 Math Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Content

6.15 Science Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Pedagogy and Content

6.16 Total, Math and Science Questionnaire Sample Regressions: Policy, Control and Climate Variables to Predict Pedagogy and Content

6.17 Total Questionnaire Sample Regressions: States, Control and Climate Variables to Predict Pedagogy and Content

6.18 Math Questionnaire Sample Regressions: States, Control and Climate Variables to Predict Pedagogy

6.19 Math Questionnaire Sample Regressions: States, Control and Climate Variables to Predict Content Dimensions A and D

6.20 Science Questionnaire Sample Regressions: States, Control and Climate Variables to Predict Pedagogy

6.21 Log Sample Multiple Correlation Significance Levels: Policy Variables and Controls Only

6.22 Total Log Sample Regressions: Group and Control Variables to Predict Climate

6.23 Total Log Sample Regressions: Policy and Control Variables to Predict Climate

6.24 Log Sample Multiple Correlation Significance Levels: Policy, Control, and Climate Variables

6.25 Total Log Sample Regressions: Group, Control, and Climate Variables to Predict Pedagogy

6.26 Total Log Sample Regressions: Group, Control, and Climate Variables to Predict Content Dimensions C and D

6.27 Math and Science Log Sample Regressions: Group, Control and Climate Variables to Predict Pedagogy and Content

6.28 Total, Math and Science Log Sample Regressions: Policy, Control and Climate Variables to Predict Content

LIST OF FIGURES

Figure *Chapter 2*

2.1 Study Design

2.2 Timeline

2.3 Mathematics and Science Content Taxonomy Dimensions

2.4 Science Content Taxonomy

2.5 Analysis File Variables

Chapter 1

STANDARD SETTING AND THE REFORM OF HIGH SCHOOL MATHEMATICS AND SCIENCE

> The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people.
> –National Commission on Excellence in Education, *A Nation at Risk*

The early 1980s was a time of intense criticism of the productivity of the education system in the United States. International comparisons of student achievement were cited to demonstrate that American students were definitely not first in the world. Within the United States, declining test scores were cited as evidence that students were losing ground in comparison to students of earlier years in their academic accomplishments, and literacy figures were cited to show that much too large a percentage of American adults were functionally illiterate. These concerns gave rise to a host of standard setting activities, many of which began in the mid-1980s and continue to the time of this writing. Lagging achievement in science and mathematics was a special target for concern, as reflected by National Educational Goal 4, "By the year 2000, U.S. students will be first in the world in science and mathematics achievement" (U.S. Department of Education, 1990, p. 5).

As states, universities, school districts, and schools took steps to increase the standards they set for students, others began to worry about the possible unintended consequences. What if higher standards for high school graduation, both in terms of course requirements and performance standards, led to increases in dropout rates? What if gains from the equity initiatives of the 1960s and 1970s were to fall victim to the standard setting activities of the 1980s?

Those who expressed reservations about increasing education standards first hypothesized that, as a result of increased standards, high school graduation rates would decrease, dropout rates would increase, and that these negative results would be especially true for minority and poor students. At least to date, that hypothesis has not come true. Statistics for the years 1972 through 1990 show no signs of a decrease in student persistence (U.S. Department of Education, 1992, p. 24). In 1990, the percentage of high school students in grades 10 through 12 enrolled the previous October who were enrolled again the following October was 96 percent for the total sample, with 96.7 percent for white students, 95 percent for black students, and 92.1 percent for Hispanic students. Over the two-decade period, student persistence had gradually improved for black students, with no clear changes for white or Hispanic students. Taking 1983 as a baseline, the year that *A Nation at Risk* was published, there is no evidence of an increase in student dropout rates. For whites, blacks and Hispanics, the percentage of students enrolled the previous October who enrolled again the following October was slightly higher in 1990 than it was in 1983. In short, there is no evidence to support a hypothesis that increases in standards during the 1980s led to decreases in high school completion rates and increases in dropouts.

When the hypothesized retention problem did not materialize, a second hypothesis emerged. Was it possible that schools were accommodating students by allowing them to meet the new standards through remedial and basic courses? To address this possibility, Clune and White (1992) analyzed transcript data on changes in course-taking patterns among graduates of high schools enrolling mostly lower achieving students in four states that had increased their high school graduation requirements. They found that (1) credits completed in academic subjects did increase by a substantial one-half year of instruction on average, (2) the increases in academic credits completed were accomplished through an overall increase in total credits rather than a substitution of academic work for other work, and (3) the largest increases in academic credit completion were in science, but substantial increases were also found in mathematics. Especially important to the argument here, the additional academic credits completed were in courses of varying levels of difficulty, not just in remedial and basic level courses. In science, many more students completed Biology 1, for example, while in mathematics, courses in prealgebra and Algebra 1 were frequent additions to the transcripts of graduating seniors.

But does all of the additional academic course taking benefit student achievement? At least in years prior to the standard setting activities, additional course taking made substantial contributions to increases in student achievement. Gamoran (1987) and Meyer (1988) have shown that intermediate level courses, such as those found by Clune and White (1992) to have experienced increases in enrollment following increases in graduation requirements, make substantial contributions to achievement test performance. Other researchers have found similar achievement benefits from high school course taking. Among College Board test takers in New York and California, Sebring (1987) found higher test scores were associated with time spent in coursework and that this relationship held for relatively low achieving students as well as high achieving students. Schmidt used data from the National Longitudinal Study of the Class of 1972 (1983a, 1983b) and Walberg and Shanahan (1983) used data from High School and Beyond to find similar results. All of these analyses statistically controlled for student background variables in reaching the conclusion that high school coursework leads to increased student achievement, a perhaps obvious but certainly important finding.

For those who doubted the benefits of increased standard setting, however, there remained yet a third hypothesis. What if, after standards were increased, the actual instruction in courses was weakened? What if the increases in numbers of students taking algebra, for example, resulted in a watered down algebra curriculum to accommodate the weaker and less motivated students? If such watering down of courses occurred, then surely the relationship between course taking and student achievement would disappear. The same curriculum that students had studied but not learned prior to high school would be taught all over again in high school and perhaps still not be learned. It was exactly this third hypothesis that served as the primary motivation for the Reform Up Close study of high school mathematics and science reported here.

A study narrowly focused on the question of whether or not increases in high school graduation requirements led to a watered down curriculum in mathematics and science, however, would almost certainly lead to misinterpretation. State increases in high school graduation requirements were not the only new initiatives. The 1980s were years of great ferment and activity for education policy at all levels. Professional organizations issued statements about the desired curriculum in high school mathematics and science. States revised their curriculum frameworks, changed their assessment programs, and adopted new textbooks.

To determine the effects of one initiative requires considering that initiative as only one of many possible influences upon practice. Thus, our investigation sought to provide a comprehensive description of curriculum policy initiatives as they might bear on high school mathematics and science practices at the beginning of the 1990s. Where did states, districts, and schools stand in terms of shifting from a basic skills focus in mathematics and science to a focus on higher order thinking, problem solving, and reasoning? Was the approach to curriculum policy formulation still consistent with the fragmented and piecemeal approaches of the past, with little articulation across levels of the education hierarchy, or had states and districts moved toward a more systemic and coherent approach to curriculum? On the one hand, the work seeks to provide careful and complete descriptions of classroom practice in high school mathematics and science and to describe that practice in its own terms, as well as against professional curriculum standards. On the other hand, the work attempts to provide explanations for variance found in classroom practice among the states, districts, and schools that might be attributed to their differences in curriculum policies.

The questions addressed include:

- What gets taught in high school mathematics and science classes, especially classes that experienced substantial enrollment increases as a result of education reform?
- To whom is this content taught?

- By whom is this content taught?
- Who decides what is taught and to whom?
- What are the effects of these decisions on students, on teachers, and on the broader system of relationships surrounding teachers and students at the school and district levels?
- What promising approaches can be identified in the provision and conduct of additional math and science instruction for students affected by the new requirements?

In addressing these issues, our work seeks to provide answers to the next generation of questions from local, state, and national policymakers about the effects of reform. The work will increase policymakers' understanding of the factors that affect curriculum decisions and student achievement.

Forward and Backward Mapping

Our research approach is to focus on a relatively specific school output, the nature and quality of the mathematics and science curriculum as offered by teachers and experienced by students. Some of our analyses begin at points most distant from the classroom and attempt to consider the full range of possible influences on the target school output, what might be called forward mapping. We consider initiatives from professional organizations, such as the National Council of Teachers of Mathematics *Curriculum Standards* (1989) and initiatives of the federal government, such as the Eisenhower Mathematics and Science Education Program, but our focus is primarily on state, district, and school initiatives as they interact and intersect across levels of the formal school hierarchy and ultimately bear on the deliberations and practices of teachers and students.

While this approach begins at the top and works down through the layers of potential influence on school practice, we do not mean to suggest anything approaching a functional relationship between policy initiatives and classroom practice. We recognize that much education policymaking occurs piecemeal over time, with each piece motivated by a different purpose. From the perspective of the classroom, the pieces often appear disjointed and fragmented, with no coherent message. Thus, despite our somewhat rational and linear approach to describing and analyzing policy initiatives and their effects, we recognize that, at least to date, education policymaking has been far from rational and linear (though the calls for systemic reform may change this in the future; see Smith & O'Day, 1991).

Other of our analyses start with classroom practice and search up the education hierarchy for possible explanations of that practice, what Elmore (1979) called backward mapping. Had we taken this approach alone, our first conclusion would surely have been that much of what takes place in high school mathematics and science instruction is quite well predicted by what took place in high school mathematics and science instruction a decade or more ago. State, district, and school policy initiatives appear to change over time at a far faster pace than does classroom practice. Our second conclusion would have been that the economic backgrounds of the students schools serve are far more predictive of the nature and quality of the mathematics and science curriculum they receive than most current thinking would see as desirable (e.g., NCTM *Standards*, 1989; and *Science for All Americans*, 1989). But our purpose here is not to build a model that serves as the best possible predictor of the enacted curriculum in high school mathematics and science; our purpose is policy analysis from the perspective of an important policy goal, upgrading high school mathematics and science. The 1980s were a particularly active time for state, district, and school policy initiatives that might bear on school curriculum (e.g., Firestone, Rosenblum, Bader, & Massell, 1991). Our analyses seek to clarify how these initiatives do or do not make sense from the perspective of practice and which, if any, of these initiatives are having influence.

Our approach to policy analysis is somewhat atypical. Most policy analyses focus on activity at one level or another of the education hierarchy, taking a broad view of initiatives at that level.

This characterizes research that seeks to describe the nature and intentions of national, state, or district initiatives. Sometimes policy analyses focus on a particular policy instrument, such as curriculum frameworks. These analyses have been enormously useful in clarifying such matters as policy formulation and policy implementation. In contrast, by focusing on a particular school output, the nature and quality of the enacted mathematics and science curricula in high school, our analyses slice the policy layer cake vertically. We look through the layers of the education hierarchy and into the classroom to clarify coherence across levels as seen from the perspective of teachers and to clarify the relative influence of various policy strategies. In conducting these analyses, we draw on a large and rich empirical data base consisting of both quantitative and qualitative data characterizing policy initiatives, classroom practice, and their connections. This attempt to connect classroom practice to policy initiatives has been identified as lacking and much needed (Stecher, 1992; McDonald, Burstein, Ormseth, Catterall, & Moody, 1990).

The Study Design

The study involved all math and science teachers in 18 high schools (grades 9 through 12) in 12 districts in 6 states. In each state, one large urban district was contrasted with one smaller suburban or rural district. In each large district, two high schools were selected to give a sense of within-district variability. In the smaller district, only a single high school was studied. In each school, there were four intensively studied target course sections, two for mathematics and two for science. In selecting target teachers and target classes, we used the criterion of enrollment gains since initiation of increased state graduation requirements in mathematics and science. Data collection began in the middle of the 1989-90 school year and continued through the 1990-91 school year.

States were selected to form contrasts in both the nature and the focus of state curriculum upgrading and standard setting initiatives. At the time of this study, Florida and South Carolina represented good examples of states using curriculum control strategies to achieve basic skills goals. In contrast, California and Arizona had already adopted the goal of increased emphasis on problem solving and application and, while using a variety of strategies for pursuing that goal, were less heavily committed to control strategies alone. Missouri and Pennsylvania stood between these two extremes in the sense that they had relatively few state curriculum upgrading initiatives of any kind. Our design contrasted large urban districts with smaller suburban/rural districts to clarify possible differing roles that districts might play in interpreting and/or adding to state initiatives. Throughout, our focus was on schools serving high concentrations of relatively low achieving students because these schools and students were the primary focus of the curriculum upgrading initiatives. The contrast between mathematics and science allowed us to explore limits on generalizability of our policy analyses across subject areas.

Data for the study can be thought of in terms of four levels. There were state level interviews of key individuals at the state education agency to learn of state initiatives relative to standard setting in high school mathematics and science. At the district level, there were interviews to determine administrators' understandings of state initiatives and how they are passed on to schools, as well as district initiatives aimed at upgrading math and science curricula. The school level data came in two forms: interviews of school administrators to learn of math and science practices in the school, and a questionnaire survey of all mathematics and science teachers in each participating high school. Data on classroom practices were obtained from both the teacher survey and the target sample of four courses per school. Target sample data were collected through teacher interviews, daily logs describing the content and pedagogy of instruction, and weekly questionnaires describing special instructional and professional activities in which teachers participated. A prelog survey was used to obtain basic demographic information. All target sample teachers were observed at least once (and usually twice) teaching the target class.

The data set is large, rich, and complex, consisting of daily records of instructional practices in target courses for 62 teachers, 116 observations of 75 target teachers, 81 target teacher interviews, 312 mathematics and science teacher questionnaires, 76 school administrator interviews, 44 district administrator interviews, and 18 interviews of education agency administrators.

The Timing of Our Study: Setting the Policy Context

Since our analyses attempt to identify policy effects on high school mathematics and science practice as well as to describe various policy initiatives from an output perspective, it becomes important to establish a rough chronology of policy initiatives leading up to the time of our study. The practices we observed during the spring semester of 1990 and the fall and spring semesters of 1990-91 must be placed as antecedent to, concurrent with, or following various policy initiatives. Clearly, attribution of practice to policy requires that practice follow policy.

For purposes here, the first significant policy event was the publication and subsequent widespread dissemination of the report *A Nation at Risk* (1983). The heart of that report's findings was that "secondary school curricula had been homogenized, diluted, and diffused to the point that they no longer have a central purpose. . . . This curricular smorgasbord, combined with extensive student choice, explains a great deal about where we find ourselves today" (p. 18). Its conclusion was that much too small a percentage of high school students are taking serious academic coursework. The report's first recommendation, then, was, "that State and local high school graduation requirements be strengthened and that, at a minimum, all students seeking a diploma be required to lay the foundations in the Five New Basics by taking the following curriculum during their four years of high school: (a) 4 years of English; (b) 3 years of mathematics; (c) 3 years of science; (d) 3 years of social studies; and (e) one-half year of computer science" (p. 24). This hard-hitting report went on to specify in general terms some of the characteristics that the required coursework was to reflect. A focus on understanding and applications was to characterize instruction in all academic subjects and for all students. Three to four years later, many states had acted on the *A Nation at Risk* recommendations by increasing the coursework required for high school graduation.

In 1989, a third series of events took place. Three reports on mathematics curriculum reform were published:

- *Everybody Counts*, published by the National Research Council;
- *Science for All Americans*, published by the American Association for the Advancement of Science;
- *Curriculum and Evaluation Standards for School Mathematics*, published by the National Council of Teachers of Mathematics.

Just as the states appeared to be responding to *A Nation at Risk*'s call for increased academic course requirements for high school graduation, these professional societies appeared to be responding to *A Nation at Risk*'s call for curriculum reform within that coursework. The three 1989 reports placed much less emphasis on rote memorization of facts and acquisition of routine skills and much greater emphasis on conceptual understanding, application, and reasoning. The shift in content was not to be just for the academically elite, but for all students. This call for curriculum reform has been characterized as "hard content for all students" (Porter, Archbald, & Tyree, 1991).

While mathematics and science clearly took the lead in the curriculum reform of the late 1980s, professional societies in other subjects were following suit. Also in 1989, three social studies reports appeared. In social studies there was less consensus about such matters as the appropriate emphasis to place on history in the curriculum, but there was consensus on the goal of ambitious content for all students (Gagnon & Bradley, 1989; National Commission on Social Studies in the Schools, 1989; Board of Directors of the National Council for the Social Studies, 1989). From 1989 through 1992, efforts to redefine the K-12 curriculum were initiated in all the core academic subject areas.

This brief chronology of policy initiatives focuses on what some have referred to as the first and third wave reforms (Firestone et al., 1991; Murphy, 1990). The so-called second wave reform had less direct bearing upon curriculum, focusing instead on restructuring classrooms, schools, and the nature of teachers' work (Firestone, Fuhrman, & Kirst, 1989). Essentially, wave two reforms challenged the top-down curriculum control strategies of the 1970s, arguing that they be replaced with empowerment strategies (Rowan, 1990). Despite the lack of direct relevance to the work reported here, since all three waves of reform coexisted at the time of our study, this second wave represents an additional backdrop for interpreting results.

The timing and character of the first and third wave reforms are important for interpreting the school and classroom results reported here. Because our study was conducted during the 1989-90 and 1990-91 school years, first wave reform effects should be observable, but third wave reform may not have had sufficient time to show effects. The lack of time for third wave effects is tempered somewhat by acknowledging that third wave reforms were foreshadowed not only in *A Nation at Risk* in 1983 but in some state curriculum frameworks, most notably the California Mathematics Framework (1985). Nevertheless, the goal of ambitious content for all students is probably too close in time to our study for our analyses to shed much light on effects.

The policy instruments of curriculum control are, at this point, fairly well known (McDonnell & Elmore, 1987). They include state and district mandates concerning curricula, instructional materials, and student testing. The intention of these mandates is to be prescriptive of desired practice, using a variety of policy mechanisms that are consistent among themselves in the practices they prescribe. These policy mechanisms are to have influence on practice by having attached to them the power of rewards and sanctions based on compliance and the authority to persuade based on legal status, consistency with norms, a basis in expertise, and charismatic advocacy (Porter, Floden, Freeman, Schmidt, & Schwille, 1988). Clearly, state high school graduation requirements fit the curriculum control strategy.

In contrast, the empowerment strategy, being newer, is much less well defined. Generally, however, the intention is to move control out of the hands of the education hierarchy and place it in the hands of teachers. The policy instruments for this approach are site-based management and deregulation. From an accountability perspective, second wave reforms replace school process requirements with school output requirements, especially the output of student achievement (Porter, Archbald, & Tyree, 1991).

Previewing the Report

Chapter 2 describes the design, instrumentation, and variable construction of the study. Criteria used for selecting states, districts, schools, courses, and teachers are explained. The taxonomies developed for describing the enacted curriculum of mathematics and science courses are described. Log procedures and questionnaires developed for collecting teachers' descriptions of their instructional practice are presented. Analyses of quality of questionnaire data are done through comparisons to teacher logs, and, in turn, the quality of teacher logs is analyzed through comparison to data from classroom observations. State-, district-, and school-level interviews developed to describe curriculum policies and practices are presented. Chapter 2 closes with a description of the variables constructed from questionnaire and log data. Where appropriate, coefficients of internal consistency are provided.

Chapter 3 gives an overview of curriculum policies and practices in the six states, 12 districts, and 18 schools. Policies considered include testing, curriculum frameworks, graduation requirements, student placement, mandated textbooks, and professional development. Schools are briefly described according to the nature of their student body and the resources available for math and science instruction. Chapter 3 closes with cross-cutting analyses of state, district, and school curriculum policy initiatives. Analyses of district responses to state initiatives suggest that districts tend to add to what states initiate and that large districts are more active in curriculum control than are small districts. The most significant curriculum control policies, however, are initiated at the school level, for example, the elimination of remedial courses and the requirement that all students take certain academic courses.

Chapter 4 provides a case study of mathematics and science curriculum policy in South Carolina, the state in our sample with the most ambitious and complete curriculum control strategies. A comprehensive and rich description of state-level curriculum policies precedes an analysis of district understandings of state initiatives and district responses together with their own additional initiatives. School-level responses and school-level curriculum policymaking are described for two urban schools and one rural school.

Chapter 5 presents description of the enacted curriculum in high school mathematics and science courses. The focus is on information collected through daily teacher logs, though questionnaire data are used to check the generalizability of log results for a larger sample of courses. For each subject, results are presented first course-by-course, then by type of course (e.g., Algebra 1), and finally for courses required of all students in a school. Where appropriate, math/science comparisons are provided. The chapter closes with a description of pedagogical practices, including the depth and breadth of instruction, the amount of noninstructional time, the use of instructional materials, and the nature and amount of homework.

Chapter 6 presents the results of multiple regressions using policy and control variables to predict classroom practice. The chapter begins with descriptive data for the variables used in the regression equations. Total sample means and standard deviations are provided for control variables: school behavior, school ability, and class ability; school climate variables: leadership, resources, institutional support, shared beliefs, and teacher control; teacher climate variables: level and amount of teacher education, teacher load, teacher responsibility, collegiality, and teacher satisfaction; and dependent variables, primarily the content and pedagogical practices reported by teachers. These descriptive data not only provide essential context for the regression results, but they augment in important ways the descriptive data in Chapter 5 by clarifying teacher perceptions of school policies and practices.

Regression results are presented first for the questionnaire data and then for the log data. Policy variables are regressed on climate variables, and then policy and climate variables are regressed on classroom practice variables. The policy variables are states, groups of states (California and Arizona versus Missouri and Pennsylvania versus Florida and South Carolina), and a policy scale (based on questionnaire data in which teachers reported the degree of state and district curriculum policy control in mathematics and science). Because of insufficient sample size, individual states were not used as policy predictors for log data.

Regression equations are presented only when the multiple regression coefficient is significant at the .05 level. Total sample regressions are presented first. Significant math and science sample regressions are presented only when the weights in the regression are different from those for the total sample.

Readers anxious to get to the results describing the enacted curriculum (Chapter 5) and analyses of factors explaining variance in classroom practice (Chapter 6) should skim Chapter 2, read the Summary and Conclusions section of Chapter 3, and skip Chapter 4. Those most interested in learning of progress made on defining and measuring opportunity to learn should go directly to the Instruments section of Chapter 2 and then to Chapter 5 for illustrations. Readers most interested in state, district, and school policy formulation might wish to go directly to Chapter 4. Of course, the full power of the report comes from its comprehensive consideration of both policy (Chapters 3 and 4) and classroom practice (Chapters 5 and 6).

Highlights

A great deal of detailed information about high school mathematics and science is contained in this report. The information ranges from detailed descriptions of instructional practices, on the one hand, to detailed descriptions of state curriculum policy initiatives, on the other. Readers will bring to the report their individual interests. From the authors' perspective, however, there are five especially noteworthy results.

First, the data are largely positive on the influence of state, district, and school standard setting activities. As a result of increased standards (e.g., increases in the number of credits of mathematics and science required for high school graduation, increases in university entrance requirements in mathematics and science, district and school steps to eliminate remedial courses in mathematics and science, and district and school efforts to have all students take at least beginning level college preparatory coursework in math and science), more high school students are receiving more worthwhile math and science instruction than ever before. Especially to the point of this study, increased enrollments in math and science courses do not appear to have significantly compromised the curriculum of those courses. In Chapter 6, course level is seen to be the most powerful predictor of course content. With course level in the equation, student ability at the class level was only an occasional and relatively weak predictor of course content. A complementary finding on this point is that, in the few instances in the study where college prep courses were required of all students in a high school, the content and pedagogy of those required courses compared favorably to the content and pedagogy of courses by the same name in high schools where the course was not required for all students.

The best news is that the content of mathematics and science courses appears not to have been compromised by increased enrollments. One might have hoped, however, that the pedagogical strategies employed by teachers would have expanded to accommodate the instructional needs of the greater diversity of students. Unfortunately, this was not the case. Throughout the sample of mathematics and science courses, instruction looked quite flat and traditional. Emphasis was on teacher lecture and student independent seatwork.

A second highlight of the report is the rich descriptions of classroom practice provided in Chapter 5. Teacher logs of instructional practices, recorded daily, collected weekly, and aggregated over a full school year of instruction, provide an unusually detailed and complete description of content and pedagogical practices of high school mathematics and science. Because these data were collected during 1990 and 1991, they can be thought of roughly as baseline data for the 1989 curriculum reform of ambitious content for all students. Our data clarify the ambitious nature of this reform. At the time of our study, the enacted curriculum in high school mathematics and science was not at all in alignment with the NCTM *Curriculum Standards* or the AAAS *Science for All Americans* standards. In mathematics, there were far too many remedial and basic courses, with essentially arithmetic as the content. Statistics, probability, and discrete mathematics, content areas emphasized in the new standards, received virtually no attention in any of the courses studied including advanced courses. All math courses reflected a heavy emphasis on exposition and equations and little emphasis on modelling, real world problems, and data collection. The emphasis remained heavily on memorization and computation. In science, the picture was similar. Science courses made little to no use of field work. Nearly half of the science courses allocated less than 5 percent of instructional time for lab work, and approximately half of the courses studied allocated less than 10 percent of instructional time to collecting data. Instead, the emphasis was heavily on memorizing facts and understanding concepts through lecture and textbook presentation.

While curriculum reform clearly has a long way to go to realize its objectives, there was one important ray of light about how to proceed. Math A, a special course designed by teachers but with state leadership in California, stood apart from all the rest. Designed as a bridge course for students who are not yet ready to take Algebra 1, Math A consists of 13 units portraying a unique NCTM-like curriculum. Teachers who will teach Math A are required to take staff development tailored to the course. With only a few exceptions, the Math A courses in the sample looked much the way they are intended to look. The content of instruction placed a unique dual emphasis on algebra and geometry, with significant attention given to measurement. Heavy use of concrete models characterized the enacted curriculum. Considerable attention was given to understanding key concepts, and less emphasis to computation. Math A also stood out from other math courses in the amount of attention given to data collection and interpretation. The only important discrepancy between the intended and the enacted curriculum for California Math A concerned probability and statistics. Despite being included in the course syllabus, probability and statistics received essentially no coverage by teachers as reflected in their log data.

A third highlight of the report is found in the comprehensive descriptions of state, district, and school curriculum policymaking reported in Chapter 3. In 1990 and 1991, curriculum policymaking had not yet taken on the coherence implied by systemic reform. None of the six states and 18 districts had anything like a comprehensive approach to supporting the ambitious reforms reflected in the NCTM *Curriculum Standards* and AAAS's *Science for All Americans*. California and Arizona were furthest along, in that both states had moved away from the minimum competency basic skills frameworks of the 1970s to adopt new curriculum frameworks calling for ambitious content for all students. But at the time of the study, neither state had in place assessment programs consistent with their frameworks. In contrast, Florida and South Carolina had not yet rejected the minimum competency basic skills agenda, and Pennsylvania and Missouri had done relatively little to provide curriculum leadership of any kind.

Teacher empowerment reforms appeared to coexist with curriculum control measures in a sort of uneasy peace. Neither type of initiative appeared to give much recognition to the other. Rather, they coexisted in ways that left unresolved the tensions that each created for the other. Regardless of whether curriculum control or teacher empowerment ultimately wins out as the preferred reform mechanism, staff development would appear to play a crucial role. With one possible exception, however, we saw nothing by way of staff development that appeared up to the challenges ahead. What little staff development we found appeared fragmented and piecemeal, identified and delivered by persons distant from the classroom, and with little if any explicit connection to strengthening academic instruction. Again, the possible exception was California's Math A, where staff development is targeted directly to the intended curriculum and where both the curriculum and the staff development were designed and delivered by teachers. Other than Math A, the staff development we found seemed largely a waste of time and money.

Our case study of curriculum leadership in South Carolina is a fourth highlight of the report. While South Carolina remained largely committed to a minimum competency basic skills curriculum, South Carolina was the one state which had a comprehensive and coherent approach to curriculum leadership. As in the other states, however, much greater attention was given to mathematics than to science. The curriculum policies described in our South Carolina case study are those developed during the period in which Richard Riley was Governor. Since Riley is now Secretary of the U.S. Department of Education, the insights our case study provide into his thinking and style as it relates to curriculum reform may also be of interest. While many will disagree with the objective of minimum competency basic skills, the South Carolina approach is impressive in its comprehensiveness and its coordination across levels of the education hierarchy.

Yet a fifth highlight of our work is methodological. The taxonomies we developed for describing high school mathematics and science curricula represent good examples of much needed languages for communicating the content and pedagogy of practice. Teachers need such languages to talk among themselves about their intentions and their successes. Education administrators need such languages for monitoring the enacted curriculum, making sure that instruction is consistent with intentions and equitably distributed. Policymakers need such languages for communicating the intended curriculum.

The daily logs and the questionnaires in the study represent two approaches that might be used for creating indicators of opportunity to learn. At the national level, school delivery standards and opportunity to learn standards are receiving a great deal of attention (Porter, 1992, 1993). A large part of the interest in such standards is stimulated by a concern for equity. If students are to be held to high standards of achievement, then schools must provide students with a fair opportunity to learn. Regardless of how controversy over school delivery standards is resolved, it seems likely that a system of school process indicators, including especially indicators of opportunity to learn, will result. To our knowledge, our validity studies of teacher log data against classroom observations and questionnaire data against teacher log data are the only validation results available for procedures that describe opportunity to learn. The validation results were very encouraging. Teacher logs represent an excellent technique where precise descriptions of opportunity to learn are needed. The questionnaire approach holds great promise as an economical description of opportunity to learn where larger samples of classes are needed.

Chapter 2

DESIGN, INSTRUMENTATION, AND VARIABLE CONSTRUCTION

The study involved all math and science teachers in eighteen high schools (grades 9 through 12) in twelve districts in six states. Policies and practices of the formal school hierarchy bearing on the nature of mathematics and science instruction as well as instructional practice were described using a variety of data collection procedures. State, district, and school administrators were interviewed; all math and science teachers were surveyed; and a subsample of math and science teachers were also interviewed and kept daily records describing their instruction over the course of a full school year. This chapter describes the design of the study, indicating how states, districts, schools, and teachers were selected for participation; the nature of the instruments used; the completeness and quality of data collected; and the variables constructed from these data for purposes of analysis.

Design

The basic design and timeline for the study are shown in Figures 2.1 and 2.2. The six states selected for study were Arizona, California, Florida, Missouri, Pennsylvania, and South Carolina. In each state, one large urban district was contrasted with one smaller suburban or rural district. In each large district, two high schools were selected to give a sense for within-district variance. In the smaller district, only a single high school was studied (and, in some cases, only a single high school existed). In each school, there were four intensively studied teachers/courses, two for mathematics and two for science, yielding a total target sample of 72 focus teachers.

In this report we identify the states by name, but we do not identify the names of the districts, schools, or teachers. The study was conducted with the promise of confidentiality to the extent identity can be protected in an intensive study of a relatively few sites.

Work began in the summer of 1989 with instrument construction and site selection. The data collection phases of the study did not begin until mid-school year of 1989/90. Because data collection was extensive, it was necessary to divide the study into two phases. Four states were studied in Phase I (California, Florida, Missouri, and Pennsylvania) and two additional states were studied in Phase II (Arizona and South Carolina). For each phase, data collection proceeded over the course of a full school year.

Unfortunately, funding did not become available in time to complete instrumentation for a start in the fall semester of 1989. For Phase I, the academic year consisted of spring semester 1990, coupled with the subsequent fall semester 1990. In Phase II, descriptions of instruction began in the fall semester of 1990 and continued through spring semester 1991. Questionnaires, observations, and interviews were primarily completed at the beginning of the first semester of study, although in Phase I it was possible to conduct these data collection activities just prior to the start of the spring semester. In most cases, a second site visit was completed toward the end of the first semester, and, in the case of Phase I, sometimes there was a third visit at the beginning of the second semester.

Responsibilities for negotiating site access and data collection were split between the University of Wisconsin-Madison research team and the Stanford University research team: Wisconsin had primary responsibility for Florida, Missouri, and South Carolina; Stanford had primary responsibility for California, Pennsylvania, and Arizona.

Selecting States

The study design has both top-down and bottom-up properties. The top-down characteristics can be seen in the criteria for selecting states. Since the purpose was to see "up close" the nature of instruction received as a result of state standard setting, states were selected that had made, relative to other states, major increases in their standards for high school mathematics and science. Primary among those standard setting initiatives were increases in the number of math and science credits required to graduate from high school.

The selection process for Phase I states occurred before this study even began. These states were the focus of a study conducted by the Center for Policy Research in Education with U.S. Department of Education, Office of Educational Research and Improvement, funding. In that study, transcript data were collected to examine, at the level of course titles, the effects of increased high school graduation requirements. Phase II states were selected during this study, and the criteria, to some extent, reflected efforts to augment the features of the Phase I states.

As can be seen from Table 2.1, Florida increased its graduation requirements in math by three credits and in science by three credits, both effective in 1987. Pennsylvania and California increased math and science requirements by two credits each, with California's new requirements taking effect in 1987 and Pennsylvania's in 1989. Missouri increased math and science requirements by one credit each, effective in 1988. According to Meyer (1990), only three states have a requirement of three science credits, and only ten states have a requirement of three mathematics credits. The Phase I sample of four states has two of only three states in the country with a requirement of both three math and three science credits (i.e., Florida and Pennsylvania).

California is a high influence, low mandate state that uses standards to push content toward higher order thinking. California policy uses a model curriculum approach, statewide testing, and textbook adoption but does very little direct mandating of courses or course content. Florida, on the other hand, is a high influence and high mandate state. Florida combines statewide testing with significant specific regulation of curriculum. The push is toward basic skills achievement. Pennsylvania provides little guidance about course content. The state develops curriculum frameworks in limited subject areas, but there is no required standardized testing at the high school level. The Educational Quality Assessment, a voluntary test, is used for planning purposes, however, by 90 percent of the local districts. Missouri specifies skills in seven subject areas, including math and science, for grades 2 through 10. Districts must test for achievement of those skills in two nonconsecutive grades between grades 7 and 10 each year. All but six districts in the state use the state-developed test. Further descriptions of state curriculum policies are provided in the next chapter, based on data collected in this study.

Phase II states are South Carolina and Arizona. As seen in Table 2.1, South Carolina requires three credits of math and two of science, representing a one-credit increase in each subject, effective 1987. The state also has a college preparatory diploma that must be obtained by students seeking to attend the state's institutions of higher education. The college preparatory diploma specifies that the math and science requirements be met with upper level courses. Arizona requires two credits in each subject, representing a one-credit increase in each subject, effective 1987.

South Carolina was perhaps the best example, at least at the time of this study, of systemic curriculum upgrading. In 1984, the South Carolina legislature passed the Education Improvement Act, which focused on basic skills improvement. The basic skills assessment program is the state's primary reform instrument, with testing in grades 1, 2, 3, 6, 8, and 10. Schools are required to remediate students who score low. The tenth-grade test serves as a high school exit exam. School and teacher incentive programs make rewards conditioned on student performance. Arizona is one of the first states to examine "essential skills" from the state level and develop an aligned assessment system to drive the curriculum. The most recent revision of the math framework was 1988, and at the time of this study, the science framework was under revision. Arizona was selected for study, however, not only because of state initiatives but because of district and high school initiatives in the state that represented exceptional efforts to upgrade the math and science curriculum for low-income students.

Selecting Districts and Schools

In each state, two districts were studied, one a large urban district with enrollment of approximately 200,000 or more and one a small suburban or rural school district with enrollment of approximately 10,000 students or fewer. The large urban district represented the study's interest in understanding what happens to high concentrations of low-income and minority students when confronting increased high school graduation requirements. The smaller districts were studied as a contrast. It is possible that state initiatives, when mediated by district bureaucracies, have effects at the school and classroom level that depend, in part, on the size and nature of the district bureaucracy.

There was some interaction between selection criteria for schools and courses and the selection process for districts. In short, the study required districts that contained schools and courses with the right properties.

The criteria for selecting schools are as follows:

1. A comprehensive grade nine through twelve high school that had the same grade level organization both before and after the state's initiative in standard setting.
2. Below average student achievement. (Where achievement data were not available, district administrators identified districts and schools in the bottom half of student achievement for the state.)
3. No major changes in population served since 1980.

The study focused on courses where enrollment gains had been substantial following increases in state requirements for graduation. Where data were available on course enrollment shifts for more schools and districts than were needed in the study, these enrollment data were used to identify courses to study that, in turn, identified both schools and districts.

For Phase I sites, the districts and schools considered were limited to the districts and schools studied in the CPRE transcript study. These were the schools for which course enrollment data were available. In Phase II, South Carolina was able to describe course enrollment shifts using a state data base. While this left open the possibility of considering all districts and schools in the state, of course, only a very few districts in South Carolina satisfy the large urban district requirement. Among the few possibilities, we selected the district that had the best examples of large enrollment gains in both math and science. For purposes of convenience, we selected the small urban or rural district from among districts nearby. In Arizona, the large urban district was selected not only because it was large but because it contained a high school that we wished to include in the study because of substantial school level curriculum upgrading efforts. Again, the small suburban or rural site was selected from those in the surrounding area that (a) served low-achieving students and (b) had high schools with courses having large enrollment gains in math and science.

Selecting Courses

Phase I. For each high school in Phase I, the transcript data were based on random samples of 25 students each completing their work in the years 1982, 1985, and 1987 or 1988. From these samples of transcripts, tables were created describing the percent of students who took and received credit by the time of graduation for each math and science course offered in the school. Enrollment gains from 1982 to 1985, from 1985 to 1987 or 1988, and overall were calculated. These data were available for two high schools in each of two districts in the four states. Tables were prepared displaying total completion percentages and changes in completion percentages by school and course within school. These, then, were the raw data for selecting courses with big increases in enrollment following increases in high school graduation requirements.

The following criteria were used for course selection:

1. Courses were selected on a school-by-school basis, rather than by district, state, or whole sample, because the data revealed substantial variation by school as to which courses had the largest enrollment gains.
2. The prime criterion for course selection was a major gain in enrollment during the period 1985 to 1987 or 1989, since this period, in all cases, included the increase in graduation requirements.
3. Where courses that satisfied the big enrollment gain criterion could not be identified, big enrollment was a substitute criterion. For example, general biology might be selected as a course because, while enrollment might have gained only ten percentage points from 1985 to 1988, enrollment in 1988 was near 100 percent.
4. Preference was given to basic courses, not only because they were typically the ones with biggest enrollment gains, but also because in some cases they represented special courses created to bridge low-achieving students into college preparatory courses.
5. Where possible, multiple sections of the same course were selected across schools for purposes of comparison.

Table 2.2 shows the courses selected for study under the column "Target Course Title." The course names listed are not those that appeared on the transcript, but rather the ERIC code course titles. From Table 2.2, it can be seen that the sample of selected courses contained six replications of algebra 1 and six replications of prealgebra. There were three replications of general math 1, two replications of general math 3, and three replications of vocational math. In science, there were seven replications each of biology general and physical science; four replications of general science; three of earth science; and two of fundamental biology/life science. Also, in that table, enrollment gains are given for the full period 1982 to 1987 or 1988 and the percent of students completing the course. The average enrollment gain was 28 percent, and the average percent completing the course was 61.4.

Phase II. The selection of target courses in Phase II differed from Phase I in two ways. First, the restriction to a focus on basic courses was relaxed in Phase II to allow inclusion of upper level courses. Second, school master schedules, rather than transcripts, provided the data for describing enrollment gains. The first decision was made on substantive grounds in an effort to extend the validity of the study. The second decision was made on pragmatic grounds. Transcript data collection is expensive. The transcript data used in Phase I were needed as the basic data for a separate study and resulted in a deliverable from this project (see Clune, White, Sun, & Patterson, 1991). For that transcript study, it was determined that data from the four states was sufficient; no additional data were needed. Thus, additional transcript collection in Phase II would have served only the purpose of course selection for the work being reported here.

To determine whether the less expensive school master schedule data would result in similar decisions to those from transcript data, two schools were studied from Phase I: one school each from the Missouri urban sample and the Missouri rural school. Using master schedule data for years 1982-1983 through 1988-1989 in the rural school and data from 1986-1987 through 1988-1989 in the urban school, target courses were selected using the same criteria as had been used in Phase I. Master schedule data were numbers of sections offered each year, rather than the transcript data percent of a random sample of 25 completing the course. In most cases and for both mathematics and science, the same courses were identified as had been identified using transcript data. In three of the eight courses to be selected, master schedule data identified no clear distinction between the target course identified from transcript data and an alternative choice. In these cases, however, the transcript data had not resulted in a sharp distinction between the course selected and an alternative. Thus, the comparison of transcript data to school master schedule data indicated that the less expensive school master schedule data were sufficient for our purposes, the one worry being that school master schedule data might not be available for some schools.

Fortunately, in the case of South Carolina, a state data base was maintained that provided number of sections and number of students by school and by course in both mathematics and science for the years 1983-1984 through 1989-1990. The state data base also included the percent of students in each course who were taking it in a college preparatory track. The procedure was to focus on the few urban districts meeting the study's criteria and using state-provided analyses of enrollment gains to select the best schools and districts for study by selecting the best examples of courses with enrollment gains. Once the urban district had been selected, state data for surrounding small suburban or rural districts meeting the study criteria were studied. Again, the schools and district that yielded the best examples of courses with large enrollment gains were selected. Table 2.3 shows the 1984-1985 and 1989-1990 data for the selected courses in South Carolina schools. One of the two math target courses for the first urban school listed was precalculus, a new course that the school created to upgrade the curriculum in mathematics. Also in that school, college track physical science was selected for study because it had a relatively large number of students and sections, not because of enrollment gains.

In Arizona, no state data base existed for course enrollments, requiring that the enrollment data be collected from the schools once they had been selected on their own right using study criteria of urban versus small suburban or rural and low achievement. Table 2.4 shows numbers of sections offered of target courses for the years 1986 and 1990. In the case of the urban district, in School 1 biology was chosen because all students were encouraged to take that class. In School 2, chemistry/physics foundations was required of all freshmen and was selected for study as was biology, which was encouraged as the second year science course. A freshman core math course, which was essentially algebra, was required of all students and had 22 sections offered, while algebra

3-4, the other target course, was the second highest enrollment math course in the school. In the suburban/rural school, even though the increase in number of sections for general chemistry was modest (e.g., from six to seven), the curriculum for the course was changed in 1989, and enrollment went up from a low of five sections in 1987. The introduction to algebra course not only showed increases, but all students are being encouraged to reach at least that level of mathematics before graduation.

Selecting Teachers

In most cases, identified target courses had multiple sections with more than one teacher involved in teaching them, thus requiring a further step in the sample selection process. The following criteria were used to select teachers/sections:

1. If a course is tracked, select only a lower track section.
2. Select the teacher teaching the largest number of sections of the target course.
3. Select the teacher with the most amount of experience in the building and with the target course.
4. For Phase I, select a teacher who will be in the building the next year and likely teaching the target course.
5. Avoid teachers near retirement, new teachers, and teachers who are judged by the department chair as exceptionally good or exceptionally bad.
6. Do not eliminate out-of-field teachers.

Obviously, there were more criteria for selecting a teacher/section than could be satisfied simultaneously. The criteria were applied in the same priority as their order above. One additional criterion took precedence over all others, the willingness of teachers to participate in the study and supply data of usable quality. As can be seen from Table 2.2, participation was a problem in some cases, resulting in some missing data. Daily records of content and pedagogy were obtained on 62 of the 72 target courses, or 86 percent. In most cases, when a Phase I teacher was lost to this study, another teacher for the same course was recruited and, beginning in the fall of 1990, provided data for that entire academic year. There were no examples where the data for the first semester were from a different teacher than the data for the second semester.

Sample Characteristics

Table 2.5 provides a breakdown of student and teacher characteristics by sex and ethnicity. Both total sample and state data are presented. Breakdowns contrasting mathematics and science are omitted because, for the most part, there were no subject differences. In all cases, the data are taken from the full sample of all mathematics and science teachers in the high schools studied, and in the case of student data, from a target course section taught by each teacher.

As can be seen in Table 2.5, slightly less than half of the students were female, 48 percent. Thirty percent of the students were white, 39 percent black, 25 percent Hispanic, and 7 percent Asian. Racial composition of the student body varied markedly by state, however, with 53 percent of the Arizona students being Hispanic and 75 percent of the Pennsylvania students being black. The highest percentage of minority students was in Florida, where only 12 percent of the students in the sampled math and science classes were white.

A slightly higher percentage of teachers were male than was true for students in their classes, 59 percent. Again, there was variation across states, with South Carolina having 59 percent of the teachers female and Pennsylvania having only 33 percent of the teachers female. The racial breakdown for teachers showed that a much heavier percentage of teachers were white than was true for their students. For the total sample, 77 percent of the teachers were white, 15 percent black, 6 percent Hispanic, and 2 percent Asian. The sharpest contrast between percent of teachers white and percent of students white was in Arizona, where 92 percent of the teachers were white yet only 34 percent of the students were white. Florida had, by far, the highest percentage of minority teachers, with 28 percent black, 13 percent Hispanic, and 2 percent Asian.

The average number of years of teaching experience for the total sample was 13.9, with very little variation across states except for Pennsylvania, where the average was 18.7. Class size was, on average, 25.1 students, with virtually no significant variation across states.

There was a wide range in the size of high school in the sample. The largest school was in a California urban district, with 28 math teachers and 23 science teachers. The smallest school was the Florida rural school, with only four math and four science teachers.

Seventy percent of the mathematics teachers in the schools studied had either a major in mathematics or mathematics education. Only 56 percent of the science teachers had a major in science or science education. Nationally, 63 percent of mathematics teachers have a major in mathematics or mathematics education, and 64 percent of science teachers have a major in science or science education (Blank & Dalkilic, 1990). Twelve percent of the teachers were not certified to teach the science or mathematics course they were teaching. The highest percentage of teachers teaching a course for which they were not certified was in California mathematics, 32 percent. For Arizona science, however, the percentage teaching without certification was nearly as high, 23 percent.

Instruments

Data for the study can be thought of in terms of four levels. There were state level interviews of key persons at the state education agency to learn of state initiatives relative to standard setting in high school mathematics and science. At the district level, there were interviews to determine understanding of state initiatives and how they are passed on to schools and to understand district initiatives. School level data came in two forms, interviews of school administrators to learn of math and science practices in the school and a questionnaire survey of all mathematics and science teachers in each participating high school. Data on classroom practices were obtained from the target sample of 72 courses. Classroom practice data were collected through daily logs describing the content and pedagogy of instruction and weekly questionnaires describing special instructional activities and professional activities in which teachers participated. A prelog survey was used to obtain basic demographic information. All target sample teachers were observed at least once teaching the target class. Interview schedules, questionnaires, log procedures, and observation protocols were constructed, pilot tested, and finalized during the summer and fall of 1989.

The study data set is large and complex, consisting of daily records of instructional practices in target courses for 62 teachers, 116 observations of 75 target teachers, 81 target teacher interviews, 312 mathematics and science teacher questionnaires, 76 school administrator interviews, 44 district administrator interviews, and 18 interviews of state education agency administrators. The following sections describe each data collection instrument and present quality of data evidence.

Logs

The central purpose of the Reform Up Close study was to characterize the nature of mathematics and science instruction that high school students received as a result of increased standards. Our approach was to identify courses that had substantial increases in enrollment following increases in state standards for mathematics and science. The primary method for describing instruction in these courses was to have one teacher for each course keep a daily record of their instructional practices, describing both the content of that instruction as well as the method of that instruction. These daily records were mailed to the University of Wisconsin-Madison on a weekly basis, where they were edited for completeness and accuracy and entered into an electronic data base.

Each teacher kept logs for an entire course, one academic year of instruction. Procedures developed represented extension of the procedures developed by the content determinants research group at the Institute for Research on Teaching at Michigan State University (Porter, Floden, Freeman, Schmidt, & Schwille, 1988; Kuhs, Schmidt, Porter, Freeman, & Schwille, 1979).

Taxonomies of mathematics and science content. For the work described here, the content of instruction means the goals and objectives for cognitive student outcomes. Not the goals and objectives of a formal curriculum, but those of the teacher; what he or she feels students should have learned if instruction was effective. Affective outcomes, while important, were not included for several reasons. Generally, they are less planful by teachers, harder for teachers to describe, and typically viewed by teachers as permeating all that they do with students. Further, it is the cognitive outcomes of instruction that have been the focus of standard setting activities, and standard setting was what motivated this study.

To describe the content of instruction from a teacher's perspective, it is useful to have a language for reporting content that is used by all teachers and in the same way. This language allows comparisons among teachers and courses on the enacted curriculum. The language should allow for comparisons in a criterion-referenced sense, for example, against the standards of the National Council of Teachers of Mathematics (NCTM, 1989), the standards of the American Association for the Advancement of Science (1989), as well as state and district curriculum frameworks.

A three-dimensional taxonomy to describe the content of elementary school mathematics was developed by the content determinants group at the Institute for Research on Teaching at Michigan State University. The three dimensions of that taxonomy described (1) general intent (e.g., conceptual understanding, skills, applications), (2) the nature of material presented to students (e.g., fractions, decimals), and (3) the operation the student must perform (e.g., estimate, multiply). In that taxonomy, the three dimensions are crossed, so that a topic can be described as the intersection of the three dimensions (e.g., story problems involving addition of whole numbers, basic subtraction facts, understanding the concept of place value). More general topics are described by the marginals of each of the three dimensions, although any one of the three two-dimensional descriptions is possible, as well.

Taking the content determinants taxonomy as a starting point, we developed languages for describing the content of instruction in high school mathematics and science. Based on reports of the Michigan State work (Porter, 1989; Porter et al., 1988), several extensions were seen as potentially useful. First, the concepts, skills, and applications distinctions needed to be refined, especially given the increased emphasis on higher order thinking and problem solving, as reflected in the NCTM Standards. Applications needed to be broken down into subcategories so that, for example, routine story problems could be distinguished from instruction involving the solution of novel problems. Second, the distinction between content and pedagogy is not clean. At macro levels, algebra is certainly distinguishable from lecture, but when these distinctions between content and pedagogy are pursued, they blur. Again, the NCTM Standards offer an example in their emphasis on student construction and active learning. For example, multiple-digit multiplication is a skill when students are asked to complete several similar problems all presented in the same format on a single page. Yet, if this same worksheet were used by a teacher to have students work in pairs, comparing their answers and explaining to each other how they did the problem and resolving any differences, then instruction is moved from skill to include conceptual understanding and problem solving. Thus, another extension of the Michigan State work was to include a dimension distinguishing different modes of presenting work. For example, verbal and written exposition was distinguished from laboratory work. Third, the Michigan State taxonomy was for elementary school mathematics. The types of content covered by the taxonomy needed to be extended to include both mathematics and science at a high school level.

After several iterations, two four-dimensional taxonomies were created, one for mathematics and one for science (see Figures 2.3 and 2.4). In developing these taxonomies, textbooks were consulted as well as reports from professional organizations (e.g., the NCTM Standards, AAAS's Science for All Americans). In addition, professors of mathematics, mathematics education, science, and science education at the University of Wisconsin-Madison and teachers in the Madison schools were consulted. In the case of mathematics, the California Mathematics Frameworks (1985a, 1985b) and the Wisconsin mathematics framework (1986) were consulted, as well as the National Assessment of Education Progress (NAEP) mathematics objectives (Educational Testing Service, 1988). In the case of science, the California Framework was consulted (1989), as were the Welsh (England) Framework (Department of Education, 1988), the National Center for Improving Science Education Framework (Bybee et al., 1989), the National Science Teachers Association Scope and Sequence (Aldridge, 1989), Kolpfer's (1971) content taxonomy, and Miller's (1986) analysis of science curricula in the United States.

The first two levels of each taxonomy, dimensions A and B, describe what comes first to most people's minds when they think about mathematics or science content. In mathematics, Dimension A has ten levels: number and number relations, arithmetic, measurement, algebra, geometry, trigonometry, statistics, probability, advanced algebra/precalculus/calculus, finite/discrete mathematics. For science, Dimension A has eight levels: biology of the cell, human biology, biology of other organisms, biology of populations, chemistry, physics, earth and space science, general science. Dimension B is nested within Dimension A, representing further breakdowns of each general content area, with ten or fewer levels of B within each level of A. For example, levels of B within statistics included collecting data, distributional shapes, central tendency, variability, correlation or regression, sampling, point estimates of parameters, confidence interval estimates of parameters, and hypothesis testing. In science, biology of other organisms was broken down into eight levels of B: diversity of life, metabolism of the organism, regulation of the organism, coordination and behavior of the organism, reproduction and development of plants, reproduction and development of animals, heredity, and biotechnology.

Dimensions C and D were the same for both the science and the mathematics taxonomy. Dimension C represents the extension of the Michigan State work to distinguish the types of material or presentation for instruction and has seven levels: exposition, pictorial models, concrete models, equations/formulas, graphical, laboratory work, field work. Dimension D is an elaboration of the Michigan State concepts, skills, and applications dimension and represents the type/levels of knowledge or skills that students are expected to acquire as a result of instruction. Dimension D has nine levels: memorize facts/definitions/equations; understand concepts; collect data; order, compare, estimate, approximate; perform procedures; solve routine problems, replicate experiments, replicate proofs; interpret data, recognize patterns; recognize, formulate, and solve novel problems/design experiments; build and revise theories/develop proofs.

A mathematics or science topic is defined by the intersection of the four dimensions of the taxonomy. In mathematics, there are 5,922 possible topics, while in science there are 4,284 possible topics (see Figures 2.3 and 2.4).

Developing a science taxonomy was more difficult than developing a mathematics taxonomy because among the mathematics community there existed greater consensus on the nature of the high school mathematics curriculum than among the science community about the science curriculum. The science taxonomy gives more attention to biology than to chemistry, physics, or even earth and space science, because biology is the single most emphasized science content in high school and because there are a variety of different biology courses available.

Each taxonomy reflects several compromises in attempting to build a common language for describing content across teachers and courses. For some teachers in some cases, the taxonomies may fail to make important distinctions and, in other cases, make distinctions finer than seem necessary. By having Dimensions C and D common across mathematics and science, the taxonomy creates a language that can address such questions as whether current recommendations for "active learning" (NCTM Standards, 1989; Rutherford & Ahlgren, Science for All Americans, 1990), are more successful in one subject than another. Finally, while each taxonomy allows for descriptions at the level of a specific topic, for most purposes, descriptions at the level of marginals of the taxonomy are more useful.

Log procedures. Three instruments were developed and used to record information about the daily instruction offered in a specific section of each target course: a daily log form, a weekly questionnaire, and a prelog form. Selection of target course and teachers has already been described. In the rare instances in which the target course was taught by a selected teacher to more than one section, we avoided selecting a section at either the beginning or the end of the day.

The primary instrument of these three was the daily log form (see Appendix A). A teacher was to complete one daily log form for each day of instruction for an entire school year. The form consists of two sides of a single sheet of paper. The first side focuses on the content of instruction; the second side focuses on pedagogical practices. After indicating their school, name, and the day's date, teachers checked whether for that day all students studied the same content. If not, they were instructed to describe content for a student near the average of the class. A second question asked teachers to indicate in number of minutes the portion of that class period spent on activities not directly related to learning the academic content of the course (e.g., announcements, attendance). This question was added after the first semester of data collection. The remainder of the front side of the log was devoted to describing the content of instruction, Item 3. Here teachers were asked to indicate up to five topics of content covered that class period. For each topic, three pieces of information were required. First, the teacher was to give an example or brief description of the topic. Next, the teacher was to write a four-digit code, positioning the topic within the taxonomy described previously. The first digit indicated the level of Dimension A, the second digit the level of Dimension B, the third Dimension C, and the fourth Dimension D. Since each dimension of the taxonomy was restricted to no more than ten levels, and since the first level was coded 0, the four-digit content code was possible. The third piece of information was the amount of emphasis given to the topic. A "3" indicated that either the topic was the only content emphasized in the period or received at least 50 percent of the time for that class. A "2" indicated the topic was one of two to four topics that day, all of which were emphasized. A "1" indicated the topic was important content, but not strongly emphasized in that class.

The back side of the log form contained four questions describing instructional method. Question 4 asked teachers to indicate the modes of instruction used: lecture, demonstration, recitation/drill, whole class discussion, students working in pairs/teams/small groups, students working independently. For each of these, the teacher circles an emphasis code having the same definitions as for a content topic, but including "0" to indicate "not used." In Question 5, a teacher indicates the types of activities students engaged in: listen/take notes, discuss/discovery lesson, complete written exercises/take a test, write report/paper, lab or field work, present/demonstrate. Again, there were four options to circle for emphasis, 0 through 3. In Question 6, the teacher indicates instructional materials used: primary text, primary workbook, supplementary text, teacher-made assignment/exercise, lab/manipulatives/equipment (not computers or calculators), computers, calculators, other material, test. In the case of textbooks and workbooks, page numbers are to be indicated. In the case of tests, a distinction is made between teacher-made tests and district- or publisher-developed tests. Teacher-made tests are to be attached to the log. The final question, 7, indicates homework assigned, with options from no homework to several indicating the type of homework. No attempt was made to characterize the amount of homework.

In addition to daily logs, there was a weekly questionnaire (see Appendix A), completed and mailed along with the daily logs each week. On the weekly questionnaire, teachers report the number of students added to or dropped from the target section. They also indicate special instructional activities that week that were not adequately described in the daily logs. A third piece of information allows teachers to indicate professional activities in which they participated during the week (e.g., conferences, conversations with colleagues, reading professional materials, being observed or observing someone else's instruction). Finally, the weekly questionnaire allows teachers to express any questions or suggestions concerning the study.

The third instrument was a pre-log survey (see Appendix A), which the teachers completed at the beginning of their descriptive work for the study. On the prelog survey teachers characterize the course (how many sections are offered and how many teachers teach one or more sections), the types of students taking the course generally, the types of students in the target section, and the specific text that the teacher will use.

These instruments and the taxonomies, as well as other instrumentation developed for the study, were reviewed by an advisory panel and consultants in a meeting on October 25 and 26, 1989. Members of the advisory panel included nationally known mathematicians, scientists, mathematics educators, science educators, and classroom teachers in both subjects (see Appendix B for a list of advisory panel members and consultants). During this meeting, several excellent suggestions were made for the revisions of the instruments and taxonomies. These revisions were incorporated, and the log procedures were piloted on November 7, 1989, with two science teachers and one math teacher from the Madison area. Again, excellent suggestions were received and revisions made. Finally, after one semester of use with Phase I teachers, a further revision was made to the log form; a question was added for teachers to describe the number of minutes during the period spent on noninstructional activities.

In the case of Phase I teachers, visits to each school were made approximately two weeks in advance of the time when official log keeping was to begin. During these site visits, teacher recruitment was finalized, teachers were trained in the procedures for keeping daily logs, and prelogs were completed. The log training manual can be found in Appendix A. Following training, teachers began immediately to keep daily logs. Thus, Phase I teachers received feedback on their log completion practices prior to the time that official log keeping began. In Phase II, which began with the fall semester, this procedure was not possible, and, in a few cases teachers began keeping daily logs several days after the school year had begun.

Teachers were instructed to complete a log for a particular day's instruction as soon after the class meeting as possible. At the beginning, when teachers were still familiarizing themselves with the procedures, completing the daily log proved difficult for some. Once the taxonomies were better known and the format of the log familiar, completion time typically ranged from five to ten minutes. Because logs were mailed to the University of Wisconsin-Madison on a weekly basis, it was possible to contact teachers who were getting behind and to talk with teachers about any problems noted in the logs received. Each teacher received $250 per semester for keeping daily logs on their target course section.

Quality of log data. As has been reported, log data were obtained for 62 of the 72 target courses for an 86 percent completion rate. Some log data were available for course sections in addition to the 62, but log data were not analyzed unless they described the majority of instruction for two full semesters of a course section. Table 2.2 indicates the number of daily logs completed for each teacher/section in the analysis file. These ranged from a low of 109 to a high of 177, with a median of 165 log days per target section.

Teachers were instructed to enter a dash rather than a content code if the taxonomy did not describe their instruction on one or more dimensions. Thus, one other evidence of the quality of log data is the number of dashes teachers felt they needed to use in describing their instruction. For Dimensions C and D, the dash option was used one-tenth of one percent of the time. For Dimensions A and B, for math teachers, the dash option was used 1.7 percent of the time, and for science teachers, .8 percent. Similarly, data from the weekly questionnaires revealed that, when asked to indicate difficulties they had in using the taxonomies and logs, teachers rarely felt the study procedures were incapable of capturing the content of their instruction.

Two additional types of evidence of the quality of log data will be presented in subsequent sections of this report. First, where class sessions were observed, agreement can be seen between the observer's descriptions of content and the teacher's log. Also, agreement between log data and questionnaire data will be presented, though the criterion is probably the log, not the questionnaire.

Classroom Observations

Seventy-five teachers were observed, 39 of them on two separate occasions and the remainder once each, for a total of 116 classroom observations. Each classroom observation yielded three types of data. First, the observer completed a daily log for the class period. Second, the observer rated the instruction on 15 five-point scales, covering such information as transitions into and out of the lesson, classroom management, student attention, and the pace of instruction (see Appendix A for these classroom observation scales). Third, the observer produced a set of notes, characterizing instruction according to content, pedagogy, student activities, and student attitudes, as well as providing a physical description of the classroom (see Appendix A for the classroom observation outline for notes). In all cases, observations were conducted at a point in time well after the beginning of a teacher's participation in the study and never at the very beginning or the very end of the academic year.

Observation data served a variety of purposes, including providing an opportunity to explore agreement between teacher-reported daily log data and an independent observer. For some Phase I sites, the initial observation on a teacher did not provide an independent description of instruction for the observed period. In these cases, the observer's log was used immediately following the class as an instructional device for helping the teacher learn to complete the log form. Thus, these data could not be used in analysis of observer/teacher agreement on log reporting. For Phase II sites, all observations were conducted independently of teachers' log completions and were used in the comparative analysis.

Forty-eight teachers, with 14 observed twice, created a data file with 62 observation logs paired with independent teacher logs. These 62 pairs of logs were used to calculate several indices of agreement for reporting the content of instruction on Dimensions A, B, C, and D of the taxonomies.

Because of the relatively small size of the data file, agreements were calculated overall rather than by subject. To define the indices of agreement, first let

T = number of topics noted by teachers,
O = number of topics noted by observer,
A = number of agreements between a teacher and observer, and
N = number of pairs of observations.

Method A: $A/[(T+O)-A]$

Using a weighted average: $\Sigma\,[A]\ /\ \Sigma\,[T+O-A]$

Using an unweighted average: $\Sigma\,[A/(T+O-A)]\ /\ N$

Method B: $[A*2]/[T+O]$

Using a weighted average: $\Sigma\,[A*2]\ /\ \Sigma\,[T+O]$

Using an unweighted average: $\Sigma [(A*2)/(T+O)] / N$

where Σ indicates a sum across the 62 pairs.

Table 2.6

Agreement Between Classroom Observations and Teacher Log Data on Content

Method	Dimension A	Dimension AB	Dimension C	Dimension D
A (Weighted)	.61	.49	.60	.47
A (Unweighted)	.78	.68	.67	.59
B (Weighted)	.76	.66	.75	.64
B (Unweighted)	.80	.70	.74	.64

As seen in Table 2.6, agreement between independent observers and teachers was quite high for all dimensions of the taxonomy. While the different methods of calculating agreement did not yield the same values, they were similar. Our preference is for method A unweighted, which conceptually is a percent of agreement calculated on each observation pair and averaged over all 62 pairs. The relatively high levels of agreement are even more impressive when one realizes they describe a single lesson; all analyses of log data are based on aggregations across a large number of lessons with the median number of lessons being 165. Obviously, the stability and reliability of such aggregations is much higher than for an individual lesson, just as the reliability of a test based on the sum across 100 items is much higher than the reliability of any one of the items by itself. There are other factors that make the levels of agreement seem impressive. The content of instruction is, to some degree, a matter of perception filtered by pedagogical quality and intentions. Further, only five topics were to be listed for a day's instruction in a section of a course. Where more than five topics are covered, there is the possibility of the observer picking a different five to describe than the teacher. Finally, as was noted earlier, the several dimensions of the taxonomies make a large number of distinctions that, in the normal course of instruction and its continuous flow, can blend at the edges of their meaning. The method of calculating agreement reported here does not allow for degrees. Either the observer and the teacher reported exactly the same level of a dimension of a topic, which was counted as agreement, or they did not, which was counted as a disagreement.

Table 2.7 provides similar analyses of agreement between observation data and log data for the back side of the log form. Recall that information on modes of instruction included lecture, demonstration, recitation/drill, whole-class discussion, students working in pairs/teams/small groups, students working independently. Student activities included listen/take notes, discuss/discovery lesson, complete written exercises/take a test, write reports/paper, lab or field work, present/demonstrate. In each case, then, a teacher indicated whether or not and to what degree each one of the six possible options occurred in that day's instruction for the target section. Again, the preferred index of agreement on whether or not a mode of instruction or student activities occurred was Method A Unweighted, giving a percent of agreement of .63 for modes of instruction and .74 for student activities. These high levels of agreement are similar to those reported for Dimensions A, AB, C, and D of the content taxonomies. Certainly they represent a lower limit on the quality of log data for analyses reported in subsequent chapters, since those analyses are based on aggregations across a median number of lessons per teacher of 165.

Table 2.7. Agreement Between Classroom Observations and Teacher Log Data on Pedagogy

METHOD	MODES OF INSTRUCTION	STUDENT ACTIVITIES
A (Weighted)	.61	.71
A (Unweighted)	.63	.74
B (Weighted)	.76	.83
B (Unweighted)	.70	.81

Questionnaire

A 30-page 85-item questionnaire was developed for purposes of this study (see Appendix A). Respondents were all math and science teachers in the 18 participating high schools. The questionnaire was broken into two sections. Part I, consisting of 46 items, was used to collect general information about the teacher and the school. Here teachers reported basic information including sex, ethnicity, teaching experience, and education. They reported on a number of school climate variables, including leadership, resources, institutional support, the degree to which beliefs about education were shared, the degree of collegiality within the school, teacher satisfaction, teacher acceptance of responsibility for student outcomes, the extent of teacher control, and the amount of institutional change in recent years. They also reported on student ability and student behavior at the school level. In Part II, consisting of 39 items, teachers were asked to characterize a specific section of a specific course they taught. Teachers described the students in the target section, their own content and pedagogical practices for that course and section, the availability and use of calculators and computers, the use of textbooks, the assignment of homework, and the nature of their grading procedures. The course and section to be described was identified by the research team in advance and indicated on the questionnaire. The intention was to obtain one questionnaire for each math or science course offered in the school. The teacher teaching the most number of sections of a course was the preferred respondent. When picking sections to describe class periods at the beginning and the end of the day were avoided where possible. In the few instances when it was not possible to cover all courses offered by using a different teacher to describe each course, some teachers were asked to complete more than one questionnaire. Each teacher received $10 for completing the questionnaire; teachers who completed more than one Part II of the questionnaire received an additional $10 for each additional Part II.

In constructing the questionnaire, a number of instruments from previous research were consulted:

Teacher Questionnaire, Parts I & II, School Reform Assessment Project, University of Southern California, 1988.

Schools and Staffing Survey (Teacher and Administrator Questionnaires), Center for Education Statistics, U.S. Department of Education, 1987.

Content Determinants Project - District Policies and Practices in Elementary School Mathematics (Questionnaire for Mathematics Coordinators/Curriculum Directors), Michigan State University, 1982.

Teacher Questionnaire, National Center for Effective Schools, University of Wisconsin-Madison, 1988.

A Questionnaire On District Mathematics Tests Administered To All Students In A Grade, The National Center for Research in Mathematical Sciences Education, University of Wisconsin-Madison, 1989.

Administrator and Teacher Survey (Teacher Questionnaire), NORC: A Social Science Research Center, University of Chicago, 1984.

National Education Longitudinal Study of 1988 (Principal and Teacher Questionnaires), NORC & WESTAT, University of Chicago, 1988.

Longitudinal Study of American Youth, Fall 1987 and Spring 1988 (Mathematics and Science Teacher Questionnaires), Northern Illinois University Public Opinion Laboratory, 1986.

1985 National Survey of Science and Mathematics Education (Principal and Teacher Questionnaires), Research Triangle Institute, Research Triangle Park, North Carolina, 1985.

National Survey of Science and Mathematics Education Follow-up (Stayers Questionnaire), Research Triangle Institute, Research Triangle Park, North Carolina, 1988.

The questionnaire was designed to take approximately one hour to complete. A draft was reviewed by the National Advisory Panel for the project and the project's consultants. Revisions were made. The instrument was piloted with six California teachers not from schools participating in the study and revised again before use.

Teachers were given the questionnaires individually during the initial site visit and were asked to complete them before the visit was over. Teachers who had not completed questionnaires at that time were given an envelope to return the completed questionnaire by mail. Repeated followups resulted in an overall 75 percent response rate, 74 percent for mathematics teachers and 77 percent for science teachers (see Table 2.8 for a summary of percent of returns of questionnaires by subject, school, district, and state). There were 168 completed questionnaires by mathematics teachers and 144 completed questionnaires by science teachers, for a questionnaire analysis file of 312 teachers (312 Part I questionnaires and 422 Part 2 questionnaires).

There was some overlap between information collected through the questionnaire, especially Part II of the questionnaire, and information collected through daily logs. In those cases of overlap, and for the target sample of teachers, data are available to explore the degree of agreement between questionnaires and logs and, in an inferential way, between questionnaires and observations. Tables 2.9 and 2.10 provide correlations between log data and questionnaire data on Dimension A of the taxonomy. As described in a later section of this report under "Scales Based on Questionnaire Data," there is not an exact correspondence in the definition of how proportion of time is calculated from the log data and the questionnaire data. The log data are true proportions of instructional time. The questionnaire data are ratios of sums of weights on a 4-point scale indicating amount of time: 0 = no time, 1 = less than 2 hours, 2 = 2 to 10 hours, and 3 = more than 10 hours. This leads to an overestimate of percent of time for topics taught a little and an underestimate for topics taught a lot. Because Dimension A differed between the two subject areas, separate correlations for each subject matter were necessary with math correlations based on a minimum sample size of 24 and science correlations based on a minimum sample size of 27.

First entries in the main diagonals of Tables 2.9 and 2.10 indicate levels of agreement between what teachers reported through daily logs aggregated to characterize a full year of instruction and what teachers reported through questionnaires where the referent was content covered in only the fall half of the school year. Second entries in the main diagonals represent correlations between log data for just the fall semester and questionnaire data. When interpreting correlations between fall log and fall questionnaire data, there are some problems. For Phase I data the fall being described in the questionnaire data is for the preceding year from the fall being described in logs; for Phase II data the questionnaire data are prospective for the fall that the log data describe as the semester unfolded.

Six of the 10 math correlations were significant for full year log data and 5 for fall log data. In science 7 of the 8 correlations were significant for full year log data and 6 for fall log data. Levels of agreement were moderate to strong for each of the two subject matter areas with two exceptions. In mathematics the first three levels of Dimension A had relatively lower agreement between logs and questionnaires. The lower agreement may be because number and number relations, arithmetic, and measurement are less self-contained and more integrated with other content than are the other topics and so more difficult to accurately report in a questionnaire format. In math, level 7 (probability) had an essential zero correlation between logs and questionnaires. Probability was content not taught by any of the teachers.

Generally log questionnaire correlations were similar for half year questionnaire data with full year log data and with half year log data. Each set of correlations is surely depressed by the fact that questionnaire data and log data are not exactly parallel in the period of time being described and whether the data were prospective or retrospective.

Table 2.11 provides levels of agreement between questionnaire and log data on Dimension D of the taxonomy (there was no questionnaire data on Dimension C). As in Tables 2.9 and 2.10, first entries are for full year log data while second entries are for fall log data. Here the comparisons between log and questionnaire data are even less straightforward; questionnaire Dimension D had only four levels while taxonomy Dimension D had nine levels. The two levels with close agreement in definition between questionnaire and log data are also the two instances of highest correlation. The correlation between data sources for degree of emphasis on memorizing facts was .48 (.45 for fall log data) and the correlation for degree of emphasis on novel problems was .34 (.39 for fall log data). In the latter case, it should be recognized that the distribution of emphasis on novel problems was highly positively skewed with most teachers spending very little time on this type of work (more detail will be presented in a subsequent chapter).

The information collected on the back side of the log form, describing instructional method and student activities, was also collected on the questionnaire. Again, because of overlap between questionnaire and log data for log teachers, it is possible to see the degree of agreement between the questionnaire data and the log data for target sections of math and science courses. For each piece of information, the wording on the questionnaire was identical to the wording on the log form. On the log form, however, daily emphasis codes were ultimately aggregated across days and translated into fractions of total instructional time. On the questionnaire, teachers were asked to indicate "About how much classroom time do you spend on each of the following with this class during a typical week?," with the options being none, 30 minutes, one hour, two hours, and three or more hours. Correlations between log and questionnaire data were as follows: lecture, .41; demonstration, .25; recitation/drill, .39; whole class discussion, .63; students working in pairs/teams/small groups, .42;

students working independently, .47. The largest four of these correlations were significant at the .001 level of significance. The correlation for drill was significant at the .01 level. Only the correlation for demonstration was not significant. For student activities, correlations were: listen/take notes, .40; discuss/discovery lesson, .52; complete written exercise/take a test, .53; write report/paper, .21 lab or field work, .65. The three largest correlations were significant at the .001 level. The correlation for listen/take notes was significant at the .01 level. Only the write report/paper correlation was not significant.

A questionnaire scale was constructed for higher order thinking and correlated with log data as follows: .37 with degree of emphasis on students' writing reports, .35 on degree of lab work, .35 with content dimension D3 (order/estimate), .47 with content dimension D6 (interpret data), and .37 with content dimension D8 (theory/proof). In the area of pedagogy, there was a questionnaire scale created on the degree to which students were involved in active learning. This questionnaire scale correlated with log data as follows: .55 with the degree to which teachers use whole class discussion as a mode of instruction and .43 with the degree to which teachers report students as engaged in discuss/discovery lessons. Both the questionnaire and daily logs asked teachers to indicate the degree to which they observed others teaching or they themselves were observed; the correlation between questionnaire and log data was .60.

These correlations between log data and questionnaire data are substantial and somewhat surprising. First, the questionnaire data are only on one half of a school year, while the log data are for a full school year. Second, Phase I questionnaire data were collected in the middle of an academic year describing the previous fall, while the log data were collected for the spring semester following the collection of questionnaire data and for the following fall semester during which time the teacher was teaching the same course but to a different section of students. For Phase II data, the questionnaire data were collected in the beginning of the fall semester so that teachers were reporting what they expected to cover in the following half year, and the logs report instruction for the following academic year. Clearly, year-long retrospective data from a questionnaire format would have yielded even higher correlations of agreement with log data.

Student Outcome Data

An effort was made to get student achievement data that could be translated into a common metric across schools, districts, and states. The primary motivation for these data was to characterize the variance in levels of student ability, both to use as a control in analyses of policy influences on enacted curriculum and in descriptive analyses to see how content is allocated differentially across levels of student achievement. We sought to characterize what students brought to the target sample classrooms, not data to capture the effects of instruction in those classrooms. Investigation of the effects of target class instruction on student achievement goes beyond the scope of this investigation. There could be no outcome measure both aligned to instruction received on the one hand and in a common metric across schools, districts, and states on the other hand.

We paid school counselors $100 to collect student test score data for all students in the target classes in their school. Achievement data were to be from nationally standardized tests preferably, or at least state level tests that provided state normed results. We requested percentile rankings rather than raw scores in the hopes that relative position in the norm group would be a suitable common metric.

Unfortunately, our approach did not result in satisfactory data. Across the sample, no test information was obtained from three of the 18 schools and for a fourth school only raw score data on a state test were available. For the analysis file of 62 target teachers, only 43, or 69 percent, had usable student achievement data. Even for that subsample, the data were based on five different tests that were administered at differing grade levels under unknown conditions and with substantial missing information at the individual student level. Using other information on student ability at the classroom level, regressions were done to predict student achievement with the hope that missing data could be inferred. Results were not satisfactory.

In retrospect, it might have been worth the effort to administer a short general achievement test in mathematics for the mathematics target sample and in science for the science target sample, perhaps drawing from publicly available National Assessment of Education Progress (NAEP) items. Testing could have been done at the beginning of participation in our study with minimal disruption to instruction. The result would have been student achievement data with known properties.

School Level Interviews

All target sample teachers were interviewed at the beginning of their participation in this study. In addition, interviews were conducted with principals, math and science department chairs, and school counselors. These interviews were conducted in person; they were audiotape recorded (in most cases, these tapes were transcribed). Interviewers kept field notes and wrote narrative summaries for each interview. A common focus of these interviews was to learn about specific policies and practices at the state, district, and school levels that bear on math and science curriculum practices (e.g., who gets taught what by whom, why, and to what effect?). Interview protocols can be found in Appendix A.

Teacher interviews. In all, 81 prospective target sample teachers were interviewed for an average of 4.5 per school. This number, which exceeds the target sample, reflects attrition in initially selected teachers and the additional interviews with replacement teachers. The teacher interview protocol asked teachers to describe instructional materials and their use in the target section. Teachers were probed about how they make content and pedagogy instructional decisions and factors that influence those decisions. Teachers were asked how students are assigned to courses and sections within courses. All interview protocols inquired about changes in policies and practices that might bear on science or mathematics instruction.

Department chair interviews. In all 18 schools, interviews were conducted with the math department chair and the science department chair for a total of 36 interviews. The interview protocol asked about department resources, teacher qualifications, and oversight of instruction. Inquiries were made about how students are assigned to courses, how teachers are assigned to courses, and the nature of any tracking system that might exist. A major focus of the protocol was curriculum decision making: who participates, how decision making is influenced, and what the effects are perceived to be. Again, respondents were probed about changes in policies and practices concerning math or science instruction. Each interview closed by asking the respondent to assess the strengths and weaknesses of the department's program.

School counselor interviews. A counselor was interviewed in all but one of the 18 participating schools. The focus of the interview protocol was on determining the exact nature of how students are assigned to courses and the role of student choice in that process. If tracks existed in the school, counselors were asked to characterize the tracks, explaining how the curriculum differed and how students were assigned. Counselors were also asked to characterize the nature of the student body at their school according to ability and behavior.

Principal interviews. Either a principal or vice-principal was interviewed in all 18 participating schools. Principals were asked to describe their mathematics and science curriculum and how curriculum decisions are made in each subject (i.e., decisions about courses, content, curriculum guidelines, textbooks). Principals were asked to assess the adequacy of resources for math and science instruction. They were also asked to characterize any important changes in curriculum policy and practice, the source of those changes, and their possible effects.

District Level Interviews

Forty-four district level interviews were conducted, ranging from 5 interviews in one district to 2 in another, with an average of 3.7 interviews per district. In each district, the assistant superintendent for curriculum, math and science specialists, and directors of testing, research, and staff development were candidates for interviews. Interview protocols were prepared for only the assistant superintendent for curriculum, the math and science curriculum specialists, and the director of testing.

Assistant superintendent for curriculum interviews. The focus of these interviews was on district policies and the district's implementation of state policies in the areas of high school mathematics and science. The protocol asked respondents to describe how decisions are made about curriculum, including curriculum frameworks, textbooks, and testing. Any changes in policies and practices in the state or district were to be characterized and their effects noted. In addition, assistant superintendents for curriculum were asked about staff development programs in mathematics and science and the supply of qualified teachers for those areas. Interviews were completed with an assistant superintendent for curriculum in all but one of the 12 participating districts.

Math and science specialist interviews. In addition to the types of information asked of the assistant superintendent for curriculum, math and science specialists were asked to characterize the programs of instruction in their area. Responses to a question concerning changes at the district level were probed for course requirements, course content, textbooks, guidelines, and testing. In each case, respondents were asked about possible influences on student achievement and any evidence for such effects. In the 12 districts, 10 math specialists and 9 science specialists were interviewed. In one district the assistant superintendent for secondary education was interviewed because there was no math or science specialist.

Testing director interviews. Directors of testing were asked to describe in detail the nature, purpose, and effects of district and state testing programs. Influences on placement of students, course offerings, content, and instructional practices were to be noted. They were probed for examples and sources of evidence for any attributions made. As in all interview protocols, respondents were asked to describe recent changes. Testing directors were interviewed in 11 of the 12 districts. In two districts an assistant superintendent for research was interviewed.

State Level Interviews

In each state, interviews were conducted with the math specialist and the science specialist. In some states, additional interviews were conducted with the assistant superintendent for curriculum and the state testing director. These interviews were conducted in the spring of 1991, some in person and some by phone. They were audiotaped and some were transcribed. In all cases, interviewers prepared a written narrative based on the interview conducted.

The purpose of state level interviews was to characterize state initiatives relevant to high school mathematics and science. Respondents were asked to characterize the state's overall strategy for improving math and science education. Descriptions of curriculum frameworks, their nature, their use, and their likely influence were requested. Similar information was asked about textbooks, testing, staff development, graduation requirements, and college entrance requirements. Respondents were to note changes in recent years, their origins, and their likely effects. Respondents were asked about any difficulties in implementing policies and any gaps in state policies or conflicts among different state policies that they see as problems.

For each policy described in an interview, the respondent was requested to provide written documents describing the policy and, where available, its implementation and effects.

Variable Construction

From the log and questionnaire data, several variables were created and put into an analysis file. In Figure 2.5, these variables are listed by type and an indication is made about whether they were based on questionnaire data, log data, or both. In using Part II of the questionnaire, each teacher was represented in the analysis file once and only once; for teachers who completed Part II for more than one course, only information for one course was used so that assumptions of statistical independence would be met in subsequent analyses. The purpose of this section is to describe how these variables were formed.

Scales Based on Questionnaire Data

Eighteen scales were formed using questionnaire items. These scales characterized the school, class, teacher, pedagogical aspects of instruction, the content of instruction, and the policy environment. Scales were formed using theory and past research to make logical judgments about items that relate to constructs of interest. For each scale, item intercorrelations and Cronbach coefficients of internal consistency were calculated. Based on results, some items were dropped. Scales varied in length from as few as two items to as many as 18 items. Alpha coefficients ranged from a low of .27 to a high of .87, with most having alphas of .55 or better. Appendix C lists each scale, the coefficient of internal consistency for that scale, and verbatim items and their weights used to define the scale.

The items forming a scale had response categories that varied from dichotomous, to 6-point Likert scales, to virtually continuous scales. To be sure that each item received equal weight, each item was put in standard score form based on the total sample prior to adding items together to form a scale. Had items been left in raw form, items with the largest standard deviations (those with the largest ranges on the response scale) would have received the greatest weight. So that scale scores would be in an interpretable metric, they were also put in standard score form based on the total sample. Thus, the total sample mean on each scale is equal to 0, and the total sample standard deviation for each scale is equal to 1.

School scales described the degree to which leadership is provided at the school level in mathematics and science, the degree to which resources are available to support good instruction in mathematics and science, the degree to which there is institutional support for teachers to be effective, the degree to which professionals in the school have shared beliefs and values about their general mission and in math and science in particular, the degree to which teachers have control over their working environment, and the degree to which policies and practices in the school concerning math and science curriculum have changed in recent years.

Scales describe the teacher's level and amount of education, the teacher's instructional load, the extent to which the teacher accepts appropriate responsibility for student achievement, the degree to which the teacher operates in a collegial way within the school, and the degree to which the teacher is satisfied with working conditions. The number of times the teacher had been observed for other than formal evaluation purposes is on a 6-point scale, from 1 for never to 6 for 10 or more times.

Several scales describe pedagogical practices. One scale is on the extent to which teachers make academic demands on students. Another scale describes the extent to which instruction requires active learning and student knowledge construction. Another scale describes the extent to which the content of instruction reflects a commitment to higher order thinking, problem solving, and indepth understanding. Student use of computers and student use of calculators are defined on 6-point scales from 1 for no use to 6 for 60 or more minutes of use by the typical student "last week."

A policy scale describes the extent to which district and state policies are present and are perceived to have influence on instruction.

Questionnaire data were also used to construct scales describing student ability at the school level, student behavior at the school level, and student ability at the class level. In constructing these scales, 16 items from the questionnaire were factor analyzed using a principle component resolution of the correlation matrix with ones in the main diagonal. Varimax rotation was used to find the best orthogonal factor matrix with number of factors determined by the number of eigenvalues equal to or greater than one. For the six-factor solution, the first factor included school level student ability and school level student behavior. Percent of white students also loaded high and positive. The second factor was a class size factor. Curiously, the factor had high loadings for percent Hispanic. The third factor was a class level student ability factor with high loadings for variables on the number of students repeating the course, level of student effort in the course, grade point average for students completing the course, and overall characterization of student ability. Despite the fact that school level student ability and school level student behavior loaded on the same factor, they were kept as separate variables because they are conceptually distinct (see Table 2.12 for the rotated factor matrix). The two-item school level student ability scale has a Cronbach alpha of .36. The eleven-item school level student behavior scale has an alpha of .87. The class level ability scale has an alpha of .62 based on four items.

For the target sample, in addition to information from the questionnaire concerning student ability, there was also information from the prelog survey. A separate factor analysis was conducted for the target sample. An 8-factor solution was obtained. Again there was a school level student ability factor separate from a class level student ability factor. The school level scale definition was the same as for the questionnaire sample. In the case of the class level student ability scale, there were three items from the prelog survey in addition to the items on the questionnaire scale: of the students in class, percent expected to graduate from high school, percent expected to graduate from college, percent expected to take more math and science than required (see Table 2.13 for the 8-factor solution).

Question 85 on the questionnaire asked teachers to describe the dimension A and B topics of their instruction, indicating for each the amount of time allocated to that topic (four levels from 0 for not taught to 3 for 10 or more hours), and also for each AB topic, dimension D information (four levels: 1 memorize, 2 routine problems, 3 novel problems, 4 develop). The referent was in all cases "the first half of this year (fall semester if your school has semesters)." Information supplied by teachers in response to question 85 was used to construct a number of variables. One variable was created for each level of dimension A in the taxonomy. These variables were formed by summing the weights indicating amount of time devoted to a topic across AB topics within each level of A and then dividing by the sum of weights for all topics taught regardless of level of dimension A. The metric is like percent of instructional time. Another variable was formed to indicate the total number of AB topics taught at least to some extent; this variable indicated breadth of content coverage. A variable describing time per AB topic was formed by a sum of weights across all AB topics divided by the number of AB topics (i.e., AB mean). This variable indicates depth of coverage. Finally, dimension D (of the taxonomy) variables were created. For the AB topics taught at least to some extent, one variable was the percent of time AB topics were taught that required students to memorize (i.e., sums of 4-point scale weights across AB topics where "memorize" was circled, divided by the sum of weights across all AB topics). The second variable was the percent of time AB topics were taught that required students to solve routine problems. The third variable was percent of time AB topics were taught requiring students to solve novel problems, and a fourth variable indicated the percent of time AB topics were taught that required students to build and revise theory and develop proofs. These four categories were ordered, with the respondents asked to indicate the highest level reached for each AB topic covered. Thus, these scales underestimate the amount of emphasis on memorize and routine problems and overestimate the amount of emphasis upon novel problems and develop proofs.

Scales Based on Log Data

Teacher logs describe daily content, modes of instruction, and student activities using emphasis codes to indicate degree. Instructions on the daily log form specified that an emphasis 3 was to be given to a topic, mode of instruction, or activity if it was the only one emphasized in the instruction that day (i.e., received more than 50 percent of the time). Emphasis 2 was used to describe one of 2-4 things emphasized in the period. Emphasis 1 described content, modes of instruction, or student activity considered important but not strongly emphasized (i.e., receiving less than 15 to 20 percent of the time).

Emphasis codes were converted to time by assigning a proportional multiplier to each emphasis code in each combination of logically possible emphasis codes for a given class session. For instance, in a class where only one topic is covered, an emphasis code of 3 is given and readily converts to 100% of class time. If two topics are covered, each is assigned a 2 and each receives 50% of the instructional time. There are other combinations where the assignment of percent of time involves some inference. Table 2.14 presents each possible pattern of emphasis codes for the topics listed on a given day and the proportion of time assigned to each level of emphasis.

For each teacher a data file was created describing the percent of total instructional time allocated to each topic in the taxonomy of topics for the subject taught. These data files can be thought of as describing the percent of time over the course of a full year of instruction allocated to a specific topic; for example, lecturing on understanding the concept of percents. From these topic level analysis files, marginal distributions of time can be constructed. For example, what percent of instruction for the year was devoted to learning about statistics? Or what percent of instruction involved lab work? Or what percent of instructional time involved interpreting data and recognizing patterns?

For the first semester of Phase I of the study, teachers were not asked to indicate how many minutes of each lesson were devoted to noninstructional activity. Thus, for some Phase I teachers, instructional time included the full period. For all Phase II teachers, however, and for those Phase I teachers who began their descriptive work in the fall semester, instructional time is the total amount of time for the period minus any time reported as devoted to noninstructional activities. Teachers reporting of noninstructional time, labeled waste time, was converted to a percent of total time and made a variable in the analysis file. Thus, allocations of instructional time sum to 100 percent and waste time as a percent of total time available is in addition to that.

Several additional variables were created using information from the back side of the log form. One variable indicated the percent of days the teacher used a test. Another variable indicated the percent of days the teacher used a textbook. Four variables described teacher homework assigned: percent of days no homework was assigned, percent of days homework was assigned that would not be corrected, percent of days homework was assigned that would be corrected, and percent of days a paper was assigned. Four variables--workshops, planning with colleagues, professional reading, and instruction observed--indicate the percent of weeks (for which a teachers provided log data) in which they participated in the four activities. In addition, a breadth of coverage scale was defined by the number of different AB topics taught over the course of the full school year. A depth of coverage variable was formed by calculating the average number of combinations of dimensions C and D that occurred per AB topic. For an AB topic like cell structure, the more different ways in which the material was presented (i.e., dimension C) and the more different types of student accomplishment sought (i.e., dimension D), the greater the depth of coverage of that topic.

From the teachers for which both questionnaire and log data were available, it was possible to estimate the degree of agreement between depth as defined on questionnaire data and depth as defined on log data. For the total sample, the correlation was .06; for the math sample, .07; and for the science sample, .17. These low correlations should not be surprising, given the different definitions for the two depth variables. In contrast, the correlation between breadth as defined on log data and breadth as defined on questionnaire data was .33 for the total sample, .13 for the math sample, and .48 for the science sample. These somewhat higher correlations in part reflect the fact that breadth was defined as the number of AB topics taught, at least to some extent, both as indicated on the questionnaire and as indicated on the logs.

An important consideration here is the degree to which the sample of lessons for which log data exist for each teacher is a representative sample of all lessons for the school year for that teacher. For the content, modes of instruction, and student activity variables, the sample spans two semesters and is based on a median number of 165 logs out of a typical school year of 180 days of instruction. For Phase II teachers and Phase I teachers beginning their descriptive work in the fall semester, most of the days with missing logs are at the beginning of the school year. Whether this introduces a bias into the data is difficult to determine. The most likely possibility for bias would be an underrepresentation of some specific content topics that are covered in the beginning of the year, probably as a part of review. A likely example would be number and number relations and arithmetic reviewed at the beginning of an algebra course. In the case of the waste time variable, for most Phase I teachers the sample is based on only one semester of data.

Course Descriptors

Two variables were used to describe the courses studied both in Part B of the questionnaire data and in the target sample. One variable was course level, with three levels: advanced (1), middle (0), and basic (-1). Course level was defined in the same way as by Clune and White (1992). They, in turn, drew from the Secondary Schools Taxonomy (Brown, Gifford, Hoachlander, Meyer, & Tuma, 1989) and, to some extent, on the Council of Chief State School Officers' State Science and Mathematics Indicator Project (Blank & Dalkilic, 1991). Essentially, Clune and White compressed the SST grading of difficulties into three levels, but not in a way that necessarily gives the same meaning to level of difficulty across subject matter areas. For example, the middle level of difficulty for math contains prealgebra which seems somewhat easier than the middle level of science which includes biology, chemistry, and physics 1. Courses were also described by "type," which in some cases was synonymous with course title but in other cases represented a grouping of different course titles. For example, in mathematics, a basic math course "type" was created that included general math as well as consumer and business math. In science, all physics courses were listed as one type even though under that type was included regular physics as well as honors physics.

Table 2.15 presents the questionnaire and target sample distributions of courses by course level and course type. From these distributions can be seen that, in the questionnaire sample and especially for the target sample, the percentage of high level courses was much higher in mathematics (53 and 59 percent, respectively) than in science (21 and 7 percent, respectively). Also from Table 2.15, it can be seen that, for most course titles, all courses were at the same course level. Exceptions were basic mathematics, where most courses were judged to be at level -1, but those having to do with consumer math were judged to be at level 0. In science, most biology courses were judged to be at level 0, but human biology was judged to be at level 1. Similarly, most chemistry and physics courses were judged to be at level 0, but honors AP physics and chemistry were judged to be at level 1.

Identification and Demographic Variables

The analysis file had several identification and demographic variables defined below:

School=1, 2, or 3 per state with 1 and 2 indicating urban district schools.

Subject=1 if science, 0 if mathematics;

State=1-6; 1=Arizona, 2=California, 3=Florida, 4=Missouri, 5=Pennsylvania, 6=South Carolina

District=Districts 1-12

Group=1 for California and Arizona, 0 for Missouri and Pennsylvania, -1 for South Carolina and Florida. This variable reflects the degree to which state curriculum policy is oriented toward a higher order thinking and problem solving curriculum versus a basic skills curriculum;

Teacher sex=1 if female, 0 if male;

Teacher ethnicity=1 if white, 0 if minority;

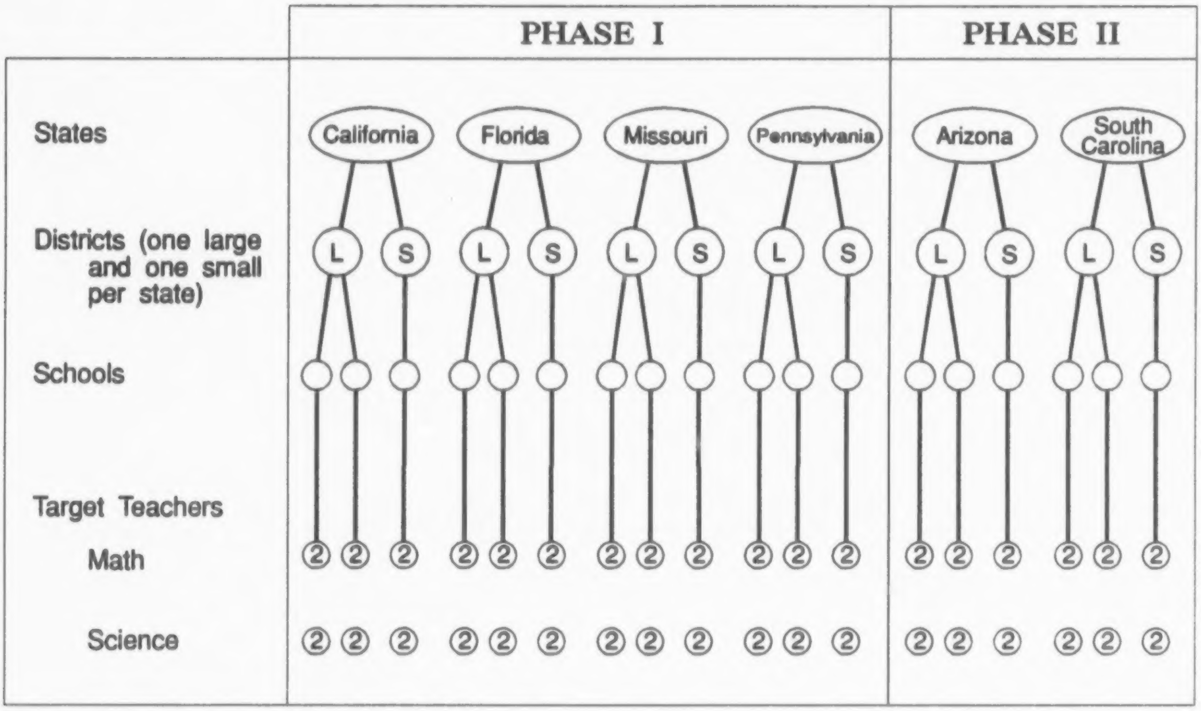
PHASE I
PHASE II
States
California
Florida
Missouri
Pennsylvania
Arizona
South Carolina
Districts (one large and one small per state)
L
S
Schools
Target Teachers
Math
Science
②

Figure 2.1. Study Design

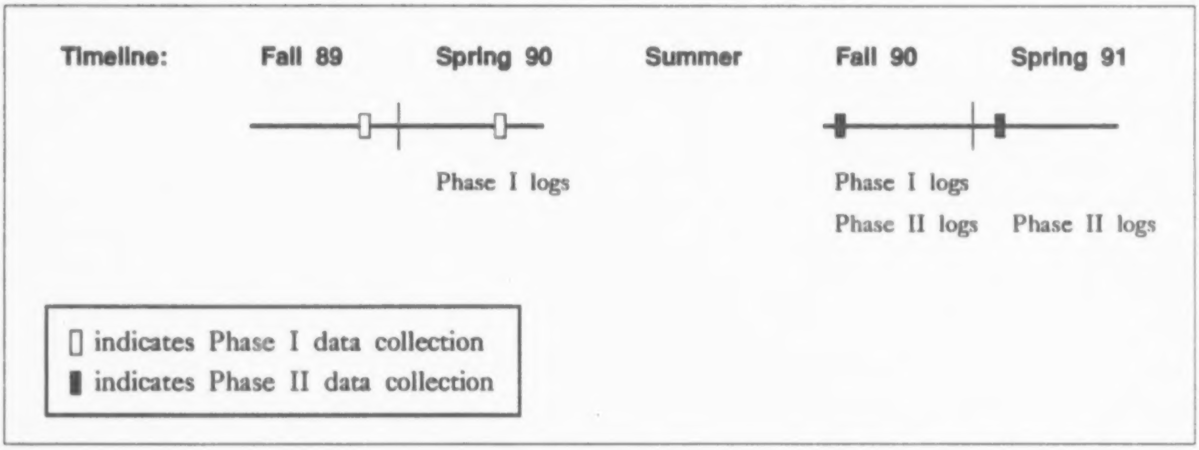
Timeline:
Fall 89
Spring 90
Summer
Fall 90
Spring 91
Phase I logs
Phase I logs
Phase II logs
Phase II logs
▯ indicates Phase I data collection
▮ indicates Phase II data collection

Figure 2.2. Timeline

CPRE/RUC
11/2/89

Mathematics Content Codes

Dimension A: 0 Number and number relations

Dimension B:

0: Sets/classification
1: Whole number
2: Ratio/proportion
3: Percent
4: Fractions
5: Integers
6: Exponents
7: Decimals (incl. scientific notation)
8: Real numbers (rational/irrational)
9: Relations between numbers (order, magnitude)

Dimension A: 1 Arithmetic

Dimension B:

0: Whole numbers
1: Ratio, proportion
2: Percent
3: Fractions
4: Integers
5: Decimals
6: Exponents
7: Radicals
8: Absolute value
9: Relationships between operations

Dimension A: 2 Measurement

Dimension B:

0: Time (not arithmetic - but units)
1: Length
2: Perimeter
3: Area
4: Volume (incl. capacity)
5: Angle
6: Weight
7: Mass
8: Rates (incl. derived and indirect)
9: Relationships between measures

Figure 2.3. Mathematics and Science Content Taxonomy Dimensions.

Dimension A: 3 Algebra

Dimension B:

0: Variable
1: Expressions
2: Linear equations or inequalities
3: Nonlinear equations or inequalities
4: Systems of equations or inequalities
5: Exponents or radicals
6: Sequences or series
7: Functions (polynomial)
8: Matrices

Dimension A: 4 Geometry

Dimension B:

0: Points, lines, segments, rays, angles
1: Relationship of lines; relationship of angles
2: Triangles and properties (incl. congruence)
3: Quadrilaterals (and polygons) and properties (incl. congruence)
4: Similarity
5: Symmetry
6: Circles
7: Solid geometry
8: Coordinate geometry (incl. distance)
9: Transformations (informal or formal)

Dimension A: 5 Trigonometry

Dimension B:

0: Trigonometric ratios
1: Basic identities
2: Pythagorean identities
3: Solution of right triangles
4: Solution of other triangles
5: Trigonometric functions
6: Periodicity, amplitude, ...
7: Polar coordinates

Dimension A: 6 Statistics

Dimension B:

0: Collecting data
1: Distributional shapes (e.g., skew, symmetry)
2: Central tendency (e.g., mean, median, mode)
3: Variability (e.g., range, standard deviation)
4: Correlation or regression
5: Sampling

6: Estimating parameters - (point est.)
7: Estimating parameters - (confidence intervals)
8: Hypothesis testing

Dimension A: 7 Probability

Dimension B:

0: Events, possible outcomes, trees
1: Equally likely - relative frequency prob.
2: Empirical probability (e.g., simulations)
3: Simple counting schemes (e.g., combinations and permutations)
4: Conditional probability
5: Discrete distributions - binomial
6: Discrete distributions - other
7: Continuous distributions - normal
8: Continuous distributions - other

Dimension A: 8 Advanced Algebra/Precalculus/Calculus

Dimension B:

0: Functional notation and properties
1: Operations with functions
2: Polynomial functions
3: Exponential functions
4: Logarithmic functions
5: Relations between types of functions
6: Matrix algebra
7: Limits and continuity
8: Differentiation
9: Integration

Dimension A: 9 Finite/Discrete Mathematics

Dimension B:

0: Sets (e.g., union, intersection, venn diagrams)
1: Logic (truth values, logical argument forms, sentence logic,...)
2: Business math (interest, insurance,...)
3: Linear programming
4: Networks
5: Iteration and recursion
6: Markov chains
7: Development of computer algorithms
8: Mathematical modeling

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11/7/89

Science Content Codes

Dimension A: 0 Biology of the cell

Dimension B:

0: Cell structure
1: Cell function
2: Transport of cellular material
3: Cell metabolism
4: Photosynthesis
5: Cell response
6: Genes

Dimension A: 1 Human biology

Dimension B:

0: Nutrition
1: Digestive system
2: Circulatory system
3: Blood
4: Respiratory and urinary systems
5: Skeletal and muscular system
6: Nervous and endocrinic system
7: Reproduction
8: Human development/behavior
9: Health and disease

Dimension A: 2 Biology of other organisms

Dimension B:

0: Diversity of life
1: Metabolism of the organism
2: Regulation of the organism
3: Coordination and behavior of the organism
4: Reproduction and development of plants
5: Reproduction and development of animals
6: Heredity
7: Biotechnology

Dimension A: 3 Biology of populations

Dimension B:

0: Natural environment
1: Cycles in nature
2: Producers, consumers, decomposers: N_2, O_2, CO_2 cycles
3: Natural groups and their segregation

4: Population genetics
5: Evolution
6: Adaptation and variation in plants
7: Adaptation and variation in animals
8: Ecology

Dimension A: 4 Chemistry

Dimension B:

0: Periodic system
1: Bonding
2: Chemical properties and processes
3: Atomic and molecular structure
4: Energy relationships and equilibrium in chemical systems
5: Chemical reactions
6: Equilibrium
7: Organic chemistry
8: Nuclear chemistry
9: Environmental chemistry

Dimension A: 5 Physics

Dimension B:

0: Energy: sources and conservation
1: Heat (content and transfer)
2: Static and current electricity
3: Magnetism and electromagnetism
4: Sound
5: Light and spectra
6: Machines and mechanics
7: Properties and structures of matter
8: Molecular and nuclear physics

Dimension A: 6 Earth and space science

Dimension B:

0: Physical geography
1: Soil science
2: Oceanography
3: Meteorology
4: Geology
5: Earth's history
6: Solar system
7: Stellar system
8: Space explorations

Dimension A: 7 General

Dimension B:

0: Nature and structure of science
1: Nature of scientific inquiry
2: History of science
3: Ethical issues in science
4: SI system of measurement
5: Science/technology and society

Dimension C:

0 Exposition - verbal and written

1 Pictorial models

2 Concrete models (e.g., manipulatives)

3 Equations/formulas (e.g., symbolic)

4 Graphical

5 Laboratory work

6 Field work

Dimension D:

0 Memorize facts/definitions/equations

1 Understand concepts

2 Collect data (e.g., observe, measure)

3 Order, compare, estimate, approximate

4 Perform procedures: execute algorithms/routine procedures (including factoring), classify

5 Solve routine problems, replicate experiments/replicate proofs

6 Interpret data, recognize patterns

7 Recognize, formulate, and solve novel problems/design experiments

8 Build and revise theory/develop proofs

		C_0									C_1	C_2	C_3	C_4	C_5	C_6
		Exposition Verbal & Written									Pictorial Models	Concrete Models	Equations Formulas	Graphical	Laboratory Work	Field Work
		D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$
	Biology of the cell (A_0)															
	B_0 Cell structure															
	B_1 Cell function															
	B_2 Trans. cell. mat.															
A_0	B_3 Cell metabolism															
	B_4 Photosynthesis															
	B_5 Cell response															
	B_6 Genes															
	Human Biology (A_1)															
	B_0 Nutrition															
	B_1 Digestive system															
	B_2 Circulatory syst.															
	B_3 Blood															
	B_4 Resp. & Urin. sys															
A_1	B_5 Skel. & musc. sys															
	B_6 Nerv. & Endo. sys															
	B_7 Reproduction															
	B_8 Human dev./behav.															
	B_9 Health & Disease															
	Biology of other organisms (A_2)															
	B_0 Diversity of life															
	B_1 Metabolism-organ.															
	B_2 Regulation-organ.															
	B_3 Coor. & beh.-org.															
A_2	B_4 Repr & dev.-plant															
	B_5 Repr & dev.-anim.															
	B_6 Heredity															
	B_7 Biotechnology															

Figure 2.4. Science Content Taxonomy

		C_0 Exposition Verbal & Written									C_1 Pictorial Models	C_2 Concrete Models	C_3 Equations Formulas	C_4 Graphical	C_5 Laboratory Work	C_6 Field Work
		D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$
	Biology of populations (A_3)															
	B_0 Natural environ.															
	B_1 Cycles in nature															
	B_2 Prod./cons./decom															
	B_3 Natur. groups-seq															
A_3	B_4 Populat. genetics															
	B_5 Evolution															
	B_6 Adap. & var-plant															
	B_7 Adap. & var-anim.															
	B_8 Ecology															
	Chemistry (A_4)															
	B_0 Periodic system															
	B_1 Bonding															
	B_2 Chem. prop./proc.															
	B_3 Atom. & Molec. st															
	B_4 Energy relations.															
A_4	B_5 Chem. reactions															
	B_6 Equilibrium															
	B_7 Organic Chemistry															
	B_8 Nuclear Chemistry															
	B_9 Envir. Chemistry															
	Physics (A_5)															
	B_0 Energy-sourc/cons															
	B_1 Heat-content/tran															
	B_2 Static & cur elec															
	B_3 Magnetism & elect															
A_5	B_4 Sound															
	B_5 Light and spectra															
	B_6 Machines and mech															
	B_7 Prop & struc-matt															
	B_8 Molec. & Nuc. Phy															

		C_0									C_1	C_2	C_3	C_4	C_5	C_6
		xposition Verbal & Written									Pictorial Models	Concrete Models	Equations Formulas	Graphical	Laboratory Work	Field Work
		D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$	$D_0 \ldots D_8$
Earth and space science (A_6)																
	B_0 Physic. geography															
	B_1 Soil science															
	B_2 Oceanography															
	B_3 Meteorology															
A_6	B_4 Geology															
	B_5 Earth's history															
	B_6 Solar system															
	B_7 Stellar system															
	B_8 Space exploration															
General (A_7)																
	B_0 Nat & Struc-Scien															
	B_1 Nat.-sci. inquiry															
	B_2 History of scienc															
	B_3 Ethical issues															
A_7	B_4 SI sys. of measur															
	B_5 Sci/technol & soc															

Variables	Questionnaire	Log
ID		
State--State	X	
District--Distr	X	
School--School	X	
Subject--Subject Sci=1 Math=0	X	
Policy		
Group--Group	X	
Policy--Policy	X	
Course Level--CRSLVL	X	
Course--Type	X	
School		
Student Ability--Schabil	X	
Student Behavior--SCB	X	
Leadership--Ldrshp	X	
Resources--Resrc	X	
Support--Insup	X	
Shared Belief--Shbelf	X	
Teacher Control--Tcntrl	X	
Change--Chng	X	
Class		
Ability--Clqabil	X	X
% Female--Pctf	X	
% White--Pctw	X	
Class Size--Clsz	X	
Teacher		
Sex--Gender Female=1 Male=0	X	
Race--Race White=1 Minority=0	X	
Level and Amount of Education--Educ	X	
Load--Load	X	
Years of Experience--Exper	X	
Responsibility--Tresp	X	
Collegiality--Colsc	X	
Satisfaction--Tsat	X	
Workshops--Wrkshp		X
Planning--Plnng		X
Professional Reading--Rdg		X
Time Observed--Obs	X	X
Times Observed--Qobs	X	

Figure 2.5. Analysis File Variables.

Pedagogy

Demands on Students--Tdsp	X	
Active Learning--Aclrng	X	
Use of Text--Qtxt 1 is yes, 2 is no	X	
Computer--Qcomp	X	
Calculator--Qcalc	X	
Test--Tst		X
Text--Txt		X
Modes of Instruction		
Lecture--Lect		X
Demonstration--Demo		X
Drill--Drill		X
Discussion--Disc		X
Small Group--Sgroup		X
Independent Study--Ind		X
Student Activities		
Notes--Notes		X
Student Discussion--Sdis		X
Completing Exercise/Test--Exer		X
Report--Report		X
Lab--Lab		X
Demonstration--Sdemo		X
Homework Not Corrected--H1P		X
Homework Corrected--H2P		X
Paper Assigned--H4P		X
No Homework--H0P		X

Content

Higher Order Thinking--HOT		X
"A" Marginals (Qa0-9)	X	
Number of AB Topics--AB#	X	
Time Per AB Topic--Abmn	X	
"D" Marginals (Qd1-4)	X	
Breadth--Brdth		X
Depth--Dpth		X
"C" Marginals (C0-6)		X
"D" Marginals (D0-8)		X
"A" Marginals (A0-9)		X
NonInstructional Time--Wst		X

TABLE 2.1

HIGH SCHOOL GRADUATION REQUIREMENTS

Total # of Required Credits (PRIOR)	Total # of Required Credits (NEW)	Effective Date of New Requirements	Change in Total # of Required Credits (CHANGE)	Requirements[a] in Core Subjects				Graduation Rate	
				Subject[b]	Prior	New	Change	Rate	Rank[c]
CALIFORNIA									
Local option	13	1987	13	English	Local option	3	3	66.7	41
				Math		2	2		
				Science		2	2		
				Social Studies		3	3		
				CORE		10	10		
				OTHER		3			
				TOTAL		13			
FLORIDA									
Local option	24	1987	24	English	Local option	4	4	62.0	50
				Math		3	3		
				Science		3	3		
				Social Studies		3	3		
				CORE		13	13		
				OTHER		11			
				TOTAL		24			
MISSOURI									
20	22	1988	2	English	1	3	2	75.6	22
				Math	1	2	1		
				Science	1	2	1		
				Social Studies	1	2	1		
				CORE	4[d]	9	5		
				OTHER	16	13			
				TOTAL	20	22			
PENNSYLVANIA									
13[e]	21[e]	1989	8	English	3	4	1	78.5	14
				Math	1	3	2		
				Science	1	3	2		
				Social Studies	2	3	1		
				CORE	7	13	6		
				OTHER	6	8			
				TOTAL	13	21			

(continued)

Table 2.1 *(continued)*

HIGH SCHOOL GRADUATION REQUIREMENTS

Total # of Required Credits (PRIOR)	Total # of Required Credits (NEW)	Effective Date of New Requirements	Change in Total # of Required Credits (CHANGE)	Requirements[a] in Core Subjects				Graduation Rate	
				Subject[b]	Prior	New	Change	Rate	Rank[c]
ARIZONA									
18	20	1987	2	English	3	4	1	63.0	47
				Math	1	2	1		
				Science	1	2	1		
				Social Studies	2.5	2.5	0		
				CORE	7.5	10.5			
				OTHER	10.5	9.5			
				TOTAL	18	20			
SOUTH CAROLINA									
18	20	1987	2	English	4	4		64.5	43
				Math	2	3[f]	1		
				Science	1	2	1		
				Social Studies	3	3			
				CORE	10	12	2		
				OTHER	8	8			
				TOTAL	18	20			

Note: Data in columns 1 - 8 are from

Belsches-Simmons, G., Flakus-Mosqueda, P., Lindner, B., & Mayer, K. (1987, March). *Recent state educational reform: Initial teacher certification, teacher compensation and high school graduation requirements.* Denver, CO: Education Commission of the States.

Education Commission of the States. (1987, August). *Mininum high school graduation course requirements.* Denver, CO: Author.

Goertz, M. E. (1988). *State educational standards: A 50-state survey.* Princeton, NJ: Educational Testing Service.

National Center for Education Statistics. (1988). *The condition of education: Elementary and secondary education.* Washington, DC: U.S. Department of Education.

Data in columns 9 and 10 are from

U.S. Department of Education. (1988, February). *State education statistics.* Washington, DC: Author, Office of Planning, Budget and Evaluation.

[a] Requirements are defined as the necessary prerequisites for a standard high school diploma.

[b] Social studies includes courses such as American History, Civics, Economics, state history, etc. English includes language arts, communication skills, etc.

[c] Rank includes District of Columbia in 51st place.

[d] Missouri requires 2 additional years from among core subjects.

[e] In 1989, Pennsylvania students must complete 13 credits in the last 3 years of high school; in 1989, they must complete 21 credits in 4 years.

[f] South Carolina's requirement of 3 credits in math may include 1 credit of computer science.

Table 2.2

Target Courses and the Final Sample of Courses

State	District	School	Department	Target Course Title	Actual Course Title	% Completing	Enrollment Gains	Semester	Number of Logs
Arizona	One	One	Math		Algebra 1-2			2&3	170
			Math		Pre-algebra 1-2			2&3	159
			Science		Biology 1-2			2&3	155
			Science						
		Two	Math		Algebra 1-2			2&3	159
			Math		Algebra 3-4			2&3	149
			Science		Biology			2&3	164
			Science		Fresh Chem/Physics			2&3	169
	Two	Three	Math		Intro to Algebra			2&3	168
			Math		Plane Geometry			2&3	171
			Science		General Chemistry			2&3	170
			Science						
California	One	One	Math	PreAlg/Int		80.7	77.0		
			Math	Alg 1	Algebra I	73.0	17.5	2&3	170

			Science	General Science		96.1	7.3		
			Science	BioGen	Human Biology (new course)	(73.0)	(43.4)	2&3	156
		Two	Math	Voc Math	Consumer Math	56.0 (32.0)	7.5 (23.5)	1&2	166
			Math	PreAlg/Int	Math A	68.0	62.3	1,2&3	165
			Science	Fund Bio/Life Sci	Life Science	52.0	43.5	1&2	146
			Science	Bio-Gen		56.0	21.8		
	Two	Three	Math	PreAlg/Int		70.9	43.2		
			Math	Math AML	Mastery Math (new course)	(41.9)	(41.9)	1&2	175
			Science	Phys Sci	Physical Science	83.8	78.3	1&2	138
			Science	Fund Bio/Life Sci	Life Science	51.6	29.4	1&2	172
Florida	One	One	Math	Basic Math Remedial	Basic Skills Math	43.4	17.4	1&2	170
			Math	Gen Math I	General Math II	52.1 (30.4)	17.4 (0.0)	1&2	179
			Science	Earth Sci	Fund. of Earth Science	56.5	52.2	1&2	159
			Science	Phys Sci	Physical Science	30.4	30.4	1&2	177
		Two	Math	Bas Math/Rem		46.4	35.7		
			Math	PreAlg Int	Pre-Algebra	53.5	10.7	2&3	163

			Science	Gen Sci	General Science	75.0	46.5	1&2	153
			Science	Phys Sci		25.0	25.0		
	Two	Three	Math	Alg 1	Algebra I	60.0	-1.5	2&3	167
			Math	Gen Math 1	General Math II	24.0 (48.0)	24.0 (21.1)	1&2	148
			Science	Phys Sci	Physical Science	84.0	49.4	2&3	166
			Science	BioGen	Biology	96.0	7.6	2&3	162
Missouri	One	One	Math	Prac Math 12	General Math	52.0 (60.0)	5.6 (60.0)	2&3	109
			Math	PreAlg/Int		(68.0)	(68.0)		
			Science	Phys Sci	Physical Science	68.0	60.9	2&3	149
			Science	Ecology	Ecology	20.0	20.0	2&3	148
		Two	Math	Voc Math	Practical Math	0.0 (41.6)	-42.8 (41.6)	1&2	173
			Math	Alg 1	Algebra I	66.6	23.8	1&2	166
			Science	Earth Sci	Earth Science	58.3	8.3	1&2	174
			Science	BioGen	Biology	62.5	26.8	2&3	169
	Two	Three	Math	PreAlg/Int	Pre-Algebra	33.3	-1.0	1&2	172
			Math	Alg 1	Algebra I	85.1	5.1	1&2	168
			Science	Phys Sci	Physical Science	62.9	46.9	1&2	165
			Science	Biogen	General Biology	88.8	28.8	1&2	161
Pennsylvania	One	One	Math	Alg 1	Algebra I	60.0	30.9	1,2&3	164

			Math	Math Tutor	Algebra I	60.0 (36.0)	30.9 (-5.6)	1,2&3	155
			Science	Gen Sci	General Biology	96.0 (44.0)	4.4 (35.7)	1,2&3	157
			Science	BioGen	General Biology	96.0		1,2&3	148
		Two	Math	Alg 1	Algebra I	73.9	17.9	1,2&3	161
			Math	Gen Math 2/3 (W)	Algebra I	73.9 (52.1)	17.9 (12.1)	1,2&3	164
			Science	Gen Sci	Biology	78.2 (26.0)	26.2 (22.0)	1,2&3	163
			Science	Phys Sci	Biology	78.2 (69.5)	26.2 (69.5)	1,2&3	158
	Two	Three	Math	Gen Math I (tchr dropped)	Geometry	50.0 (34.6)	34.0 (-49.4)	2&3	169
			Math	Gen Math 2/3	Algebra I	76.9 (46.1)	28.9 (-17.9)	1&2	151
			Science	Earth Sci	Earth Science	100.0	24.0	1&2	172
			Science	BioGen	General Biology	100.0	4.0	1&2	177
South Carolina	One	One	Math		Algebra II			2&3	173
			Math		Pre-Calculus			2&3	155
			Science		C.P. Physical Science			2&3	168
			Science		C.P. Chemistry			2&3	148
		Two	Math		Algebra II			2&3	174
			Math		Geometry			2&3	152

			Science		General Science			2&3	167
			Science						
	Two	Three	Math		General Math Basic			2&3	161
			Math		Algebra II			2&3	123
			Science		Physical Science			2&3	173
			Science		Modern Biology			2&3	173

( ) indicates data on target course when actual course was not the same.

Table 2.3

Enrollment Data for South Carolina Target Courses*

			1984-85	1989-90
School 1	Math	Algebra II	2	4
		Pre Calc	Not Offered	Not Offered
	Science	C P Physical Sci	17	12
		C P Chemistry	4	3
School 2	Math	Alg II	3	6
		Geom	5	9
	Science	Gen Sci	1	3
		C P Chem	3	5
School 3	Math	Gen Math Basics	2	6
		Alg II	1	4
	Science	Physical Sci	2	8
		Modern Bio	5	6

*Entries are number of sections offered.

Table 2.4

Enrollment Data for Arizona Target Courses*

			1986	1990
School 1	Math	Algebra 1-2	8	11
		Pre Alg 1-2	4	13
	Science	Biology 1-2	All Students	All Students
		Chemistry	5	8
School 2	Math	Algebra 1-2	All Students	All Students
		Algebra 3-4	8	10
	Science	Biology	All Students	All Students
		Freshman Chemistry/Physics	All Students	All Students
School 3	Math	Intro to Alg	11	14
		Plane Geom	7	9
	Science	Gen Chem	6	7
		Life Sci	0	10

*Entries are number of sections offered.

Table 2.5

Sample Characteristics

	Total Sample	Arizona	California	Florida	Missouri	Pennsylvania	South Carolina
Student Characteristics							
Percent Female	48	49	42	48	50	47	54
Percent White	30	34	32	12	43	24	35
Percent Black	39	11	6	66	53	75	61
Percent Hispanic	25	53	37	21	2	2	2
Percent Asian	7	1	32	0	1	2	1
Teacher Characteristics							
Percent Female	41	47	34	35	45	33	59
Percent White	77	92	73	57	83	79	68
Percent Black	15	5	5	28	17	21	27
Percent Hispanic	6	3	15	13	0	0	0
Percent Asian	2	0	8	2	0	0	0
Years of Experience	13.9	13.3	13.0	13.9	13.0	18.7	12.6
Class Size	25.1	25.0	28.1	25.5	21.9	24.4	24.2

Table 2.8

QUESTIONNAIRE RESPONSE RATE

State	District	School	Department	Questionnaire
Arizona	One	One	Math	14/15
			Science	7/13
		Two	Math	14/24
			Science	12/19
	Two	Three	Math	16/11*
			Science	16/10*
State Total Percent			Math	.78
			Science	.83
California	One	One	Math	6/12
			Science	7/10
		Two	Math	15/28
			Science	16/23
	Two	Three	Math	12/12
			Science	10/9*
State Total Percent			Math	.63
			Science	.76
Florida	One	One	Math	11/17
			Science	10/17
		Two	Math	12/14
			Science	12/13
	Two	Three	Math	4/4
			Science	4/4
State Total Percent			Math	.77
			Science	.76
Missouri	One	One	Math	5/8
			Science	8/8
		Two	Math	8/10
			Science	6/8

	Two	Three	Math	10/9*
			Science	9/9
State Total Percent			Math	.85
			Science	.92
Pennsylvania	One	One	Math	5/12
			Science	6/8
		Two	Math	11/12
			Science	9/13
	Two	Three	Math	8/6*
			Science	4/5
State Total Percent			Math	.73
			Science	.73
South Carolina	One	One	Math	5/8
			Science	3/7
		Two	Math	7/9
			Science	1/5
	Two	Three	Math	5/5
			Science	4.4
State Total Percent			Math	.77
			Science	.50
Overall Percent			Math	.74
			Science	.77

*numerator set equal to denominator.

Table 2.9

Correlations Between Questionnaire and Log Data on Content Dimension A: Math

	Number A0	Arith. A1	Meas. A2	Alg. A3	Geo. A4	Trig. A5	Stat. A6	Prob. A7	PreCalc. A8	Discrete Math A9
QA0	.42[1], .35[2]	.57*, .66**	.41, .35	-.08, -.09	-.66**, -.62*	-.34, -.30	-.04, -.02	-.24, -.10	-.30, -.31	-.16, -.69**
QA1	.41, .27	.29, .38	.12, -.05	.07, .13	-.53*, -.54*	-.35, -.32	-.16, -.02	-.26, .26	-.30, -.30	-.25, -.50
QA2	-.09, -.07	.36, .28	.25, .58*	-.46, -.44	.32, .23	-.00, -.03	-.10, -.00	-.11, -.19	-.08, -.09	.24, .18
QA3	-.29, -.23	-.53*, -.51*	-.52*, -.49	.76**, .77**	-.30, -.26	-.00, .04	.12, .22	.04, .30	.06, .08	-.29, -.18
QA4	-.25, -.22	-.38, -.42	-.14, -.19	-.22, -.24	.93**, .89**	.03, -.04	.02, -.12	-.06, -.15	-.03, -.04	.15, .75**
QA5	-.31, -.29	-.32, -.37	-.14, -.15	-.23, -.21	.38, .28	.92**, .86**	-.09, -.09	.82**, -.11	.86**, .86**	.35, .74**
QA6	.18, .33	-.09, -.10	.15, -.17	-.05, -.22	.13, .40	-.09, -.07	.50*, -.08	.03, -.10	-.06, -.07	.24, -.12
QA7	-.00, .02	.10, .02	-.13, .02	-.10, -.29	.13, .41	-.09, -.07	.44, .07	-.05, -.09	-.06, -.07	-.17, -.11
QA8	-.30, -.29	-.35, -.38	-.24, -.17	.13, .18	-.06, -.14	.79**, .80**	-.18, -.10	.76**, -.12	.80**, .80**	.17, .33
QA9	.20, .43	-.14, -.20	.22, .04	-.23, -.28	.25, .28	.33, .31	.30, -.01	.28, -.17	.26, .26	.59*, .22

*significant at .01
**significant at .001

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[1] First entries in each cell represent correlations between a full year of log data and a fall semester of questionnaire data.

[2] Second entries in each cell represent correlations between fall semester log and questionnaire data, but Phase I questionnaire data describes the fall semester of the year preceding the fall semester described by logs and Phase II questionnaire data are prospective.

Table 2.10

Correlations Between Questionnaire and Log Data on Content Dimension A: Science

	Bio. Cell A0	Bio. Human A1	Bio. Organism A2	Bio. Pop. A3	Chem. A4	Physics A5	Earth. Sci. A6	Gen. Sci. A7
QA0	.71**[1], .73**[2]	.54*, .47	.71**, .64**	.31, .33	-.60**, -.48	-.60**, -.46	-.17, -.23	-.02, -.03
QA1	.49*, .50*	.61**, .32	.48*, .67**	.13, .01	-.39, -.31	-.39, -.33	-.20, -.19	-.15, -.13
QA2	.83**, .84**	.42, .60**	.78**, .68**	.13, .15	-.50*, -.40	-.53, -.44	-.28, -.25	-.21, -.32
QA3	.33, .37	.27, .11	.53*, .46	.62**, .71**	-.45, -.36	-.45, -.37	-.17, -.13	-.01, -.10
QA4	-.20, -.24	-.26, -.22	-.27, -.30	-.24, -.23	.66**, .70**	-.03, -.13	-.14, -.22	.14, .17
QA5	-.44, -.44	-.34, -.28	-.43, -.42	-.27, -.22	.19, .12	.81**, .66**	-.11, -.14	.08, .20
QA6	-.27, -.26	-.20, -.15	-.27, -.25	.07, -.03	-.21, -.18	-.14, -.07	.88**, .96**	-.23, -.37
QA7	-.32, -.33	-.17, -.11	-.35, -.33	-.19, -.09	.52*, .23	.39, .41	-.39, -.36	.32, .40

*significant at .01
**significant at .001

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[1] First entries in each cell represent correlations between a full year of log data and a fall semester of questionnaire data.

[2] Second entries in each cell represent correlations between fall semester log and questionnaire data, but Phase I questionnaire data describes the fall semester of the year preceding the fall semester described by logs and Phase II questionnaire data are prospective.

Table 2.11

Correlations Between Questionnaire and Log Data on Content Dimension D

	DO Mem. Facts	D1 Understand	D2 Col. Data	D3 Order/Est.	D4 Routine Proced.	D5 Routine Prob.	D6 Inter. Data	D7 Novel Prob.	D8 Theory/ Proof
QD1 Mem. Facts	.48**[1], .45**[2]	.24, .18	.07, .05	-.09, -.13	-.36*, -.32	-.36*, -.33	-.17, -.17	-.26, -.22	-.07, -.05
QD2 Routine Prob.	-.03, -.06	-.22, -.20	-.15, -.11	.07, .02	.18, .19	.11, .17	.15, .07	-.17, -.24	.04, -.01
QD3 Novel Prob.	-.36*, -.35	.07, -.12	.18, .18	.05, .13	.06, .00	.17, .10	-.01, .11	.34, 39*	-.07, -.07
QD4 Develop	.07, .13	.00, -.06	-.12, -.18	-.10, -.09	.01, .04	-.05, -.09	-.05, -.11	.07, .08	.14, .22

*significant at .01
**significant at .001

---

[1] First entries in each cell represent correlations between a full year of log data and a fall semester of questionnaire data.

[2] Second entries in each cell represent correlations between fall semester log and questionnaire data, but Phase I questionnaire data describes the fall semester of the year preceding the fall semester described by logs and Phase II questionnaire data are prospective.

Table 2.12

Questionnaire Sample Student Ability Factor Matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Subject	-.05	.03	.03	-.56	.64	-.02
CRSLVL	.12	-.03	-.06	.80	.11	.14
Q42	-.74	-.11	.06	-.04	-.07	.15
Q46I	.04	-.04	.02	.02	-.01	.85
Q50	.21	.04	-.46	.45	.39	.07
GPA	.23	.12	-.73	.07	.26	.03
SCB	.57	-.07	-.04	-.07	-.01	-.57
Q47	.12	.53	.46	.31	.07	-.19
PCTF	-.18	-.22	-.07	.42	.11	-.24
PCTW	.85	-.22	-.08	.09	.10	.15
PCTB	-.70	-.52	.23	-.03	-.06	-.13
PCTH	.09	.79	-.20	-.12	-.18	.02
PCTL	-.10	.80	-.11	-.11	.06	.00
PCTR	-.00	.06	.28	-.09	-.69	.00
Q51	.22	-.13	.16	.28	.59	-.02
Q53	-.04	-.17	.73	-.08	.09	.13

Q42	School student ability
Q46I	School student reading level
Q50	This class ability
SCB	School student behavior scale
Q47	Class size
PCT	Percent, female, white, black, Hispanic, limited English, course repeaters
Q51	Percent who will stay in course
Q53	Student effort

Table 2.13

Target Sample Student Ability Factor Matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Subject	-.10	-.15	-.05	-.67	-.04	.27	.37	.12
CRSLVL	-.01	.22	-.15	.79	.11	.18	.05	-.10
TRACK	.39	.53	-.35	.34	.06	.15	.18	.13
Q42	-.77	-.30	-.09	.10	.06	.11	-.12	.09
Q46I	-.27	-.18	.09	.54	.02	-.27	.25	.26
Q50	-.08	.41	-.06	.47	-.21	.38	.02	.28
GPA	.31	.09	.14	.05	-.77	.17	-.04	.22
SCB	.66	.17	.06	-.22	-.02	.13	-.15	-.23
P4C	.12	-.30	.00	.03	-.02	.08	-.72	.29
P5A	.41	.65	-.33	-.12	-.11	-.04	.07	.24
P5B	.20	.84	-.07	.07	-.03	.10	.17	.01
P5C	.22	.78	.10	.34	-.03	.18	.07	.07
Q47	-.12	.27	.14	.04	.71	.12	-.11	.29
PCTF	-.01	.15	-.08	-.04	.03	-.05	-.01	.83
PCTW	.86	.13	-.09	.16	-.07	.06	.10	.18
PCTB	-.75	-.05	-.60	-.11	.05	-.11	-.04	-.07
PCTH	.08	-.07	.94	-.03	-.01	.06	-.02	-.09
PCTL	.03	-.08	.82	-.08	-.00	-.32	-.14	-.01
PCTR	-.10	-.16	.12	.04	.04	-.91	-.04	.07
Q51	.24	.07	-.14	.01	.07	.11	.72	.20
Q53	.20	-.29	-.02	.13	.66	-.04	.17	.01

Q42	School student ability
Q46I	School student reading level
Q50	This class ability
SCB	School student behavior scale
P4C	Ability level from prelog; "1" is high ability
P5A	Percent expected to graduate from high school
P5B	Percent expected to graduate from college
P5C	Percent expected to take more math and science than required
Q47	Class size
PCT	Percent, female, white, black, Hispanic, limited English, course repeaters
Q51	Percent who will stay in course
Q53	Student effort

Table 2.14

Conversion of Emphasis Codes to Percent of Instructional Time

Patterns of Emphasis Codes	Assignment of Percent Time			Code No.
	Emphasis 1	Emphasis 2	Emphasis 3	TNH
3			1.000	313
22		.500		422
13	.200		.800	423
23		.400	.600	523
122	.200	.400		532
113	.150		.700	533
1112	.200	.400		542
222		.333		632
123	.150	.250	.600	633
1112	.150	.350		642
1113	.150		.550	643
11112	.150	.400		652
223		.200	.600	733
1222	.100	.300		742
322	.100	.200	.600	743
11122	.100	.350		752
11113	.100		.600	753
111112	.120	.400		762
2222		.250		842
1223	.100	.200	.500	843
11122	.140	.240		852
11123	.100	.200	.500	853
111122	.100	.300		862
111113	.080		.600	863
2223		.150	.550	943
12222	.120	.220		952

11223	.080	.160	.520	953
111222	.113	.220		962
111223	.060	.210	.550	963
22222		.200		1052
12223	.050	.150	.500	1053
112222	.100	.200		1062
111223	.050	.150	.550	1063
22223		.100	.600	1153
122222	.100	.180		1162
112223	.050	.130	.510	1163
111111		.166		1262
122223	.050	.100	.550	1263
222223		.100	.500	1363

T = sum of emphasis codes
N = number of emphasis codes
H = highest emphasis code

Table 2.15

Questionnaire and Target Sample Distributions by Course Level and Course Type

Subject	Course Type	Questionnaire				Target			
		n	-1	0	1	n	-1	0	1
Math	Not Grouped	10	0	6	4	0	0	0	0
	Basic Math	57	49	8	0	8	7	1	0
	PreAlgebra/Math A	14	0	14	0	5	0	5	0
	Algebra I	29	0	0	29	11	0	0	11
	Algebra II	21	0	0	21	4	0	0	4
	Geometry	15	0	0	15	3	0	0	3
	Trig/PreCalc	12	0	0	12	1	0	0	1
	Calculus	6	0	0	6	0	0	0	0
	Total Math	164	49	28	87	32	7	6	19
	Percent		30%	17%	53%		22%	19%	59%
Science	Not Grouped	22	9	1	12	0	0	0	0
	General Science	16	16	0	0	2	2	0	0
	Physical Science	25	25	0	0	8	8	0	0
	Earth Science	7	7	0	0	3	3	0	0
	Life Science	6	6	0	0	2	2	0	0
	Biology	34	0	29	5	12	0	11	1
	Ecology	5	0	0	5	1	0	0	1
	Chemistry	14	0	10	4	2	1	1	0
	Physics	14	1	9	4	0	0	0	0
	Total Science	143	64	49	30	30	16	12	2
	Percent		45%	34%	21%		53%	40%	7%

CHAPTER 3

MATH AND SCIENCE CURRICULUM UPGRADING POLICIES AND PRACTICES AT THE STATE, DISTRICT, AND SCHOOL LEVEL

The purpose of this chapter is to describe state, district, and school mathematics and science curriculum upgrading strategies for the sample studied. In Chapter 2, brief descriptions of the state upgrading initiatives were provided as a part of the study design. Specifically, information was given about increases in high school graduation requirements. In what follows, the full array of state upgrading initiatives is presented.

States are described in alphabetical order. For each state there is a state description, the urban district description followed by descriptions of the two urban schools, and then the suburban/rural district description followed by the suburban/rural school description. The approach is to provide a broad policy context for understanding classroom level response. In addition to graduation requirements, descriptions cover testing programs, curriculum frameworks, textbook policies, professional development, teacher evaluation, tracking and placement decisions, and access to instructional resources. To provide further context, the student body of each school is characterized.

The focus is on breadth of coverage rather than depth; these are not case studies. The goal is to provide comprehensive descriptions of initiatives at state, district, and school levels that might have influence upon classroom practice. While interesting in its own right, the information also will be useful in making sense out of classroom level data provided in Chapters 5 and 6.

A case study was done of the South Carolina portion of our sample (i.e., the state, two districts, and three schools) and is presented in Chapter 4. This South Carolina case study provides a rich description of the implementation process for curriculum upgrading strategies and their interactions across the levels of schooling. South Carolina was selected because, as a state, it represented the best example of a coherent and systemic initiative to upgrade mathematics and science instruction. Unfortunately, at the time of our study the South Carolina curriculum goal was one of basic skills and so does not reflect more recent emphasis on higher order thinking and problem solving.

The state, district, and school descriptions that follow and the case study in Chapter 4 are based primarily on data from interviews at the state, district, school, and classroom level and from site visits.

Arizona

Arizona employs a top-down strategy, utilizing mandates as the primary policy instrument. The state attempts to drive curriculum through mandatory assessment and emphasis on state essential skills. The state's overall strategy is to communicate and target its limited resources toward fulfilling the state framework.

Testing. Arizona is one of the first states to examine essential skills from the state level and develop an assessment system to drive the curriculum. At the time of our study, Arizona was in the process of implementing a criterion-referenced test, the Arizona State Assessment Program (ASAP), designed to be aligned with the state essential skills (see below). Students will be tested in grades 3, 8, and 12 and will be randomly assigned specific sections of the test, which has a total of 67 performance assessment units. State specialists serve as liaisons for each district to help them prepare for the ASAP. The new assessment will emphasize hands-on learning, application, reasoning, and other higher order thinking skills. Performance assessments are not multiple choice and have been developed for math and language arts. The science assessments were scheduled to be ready in time for the 1992-1993 school year.

This test will eventually replace the current norm-referenced test, TAP, which is offered at the 12th-grade level in the spring, and ITBS, which is administered each spring, in grades 2-12. The TAP test has four sections: Reading Comprehension, Written Expression, Math, and Using Sources of Information. A criticism of the norm-referenced testing procedure is that TAP and ITBS scores are submitted to the state, and results of the tests are not received by teachers until the following fall, when they no longer teach the students who took the exam.

In addition, a state legislative committee examined TAP alignment with the state essential skills and found only a 30% alignment. Hence, the committee developed the ASAP, which is designed to be 100% aligned with the state essential skills.

Many larger districts who had aligned their curriculum to the ITBS to raise district test scores are resisting the new assessment because they fear that their test scores will drop. Prior to the advent of the new assessment, no one took the essential skills very seriously; districts and schools took the bits and pieces that they wanted. However, now they are working to get themselves ready for the ASAP and are paying closer attention to the essential skills.

Frameworks. In 1972, the state of Arizona set forth a list of essential skills. The essential skills have been revised several times since then (the current math document was written in 1988; the science document is currently under revision). Schools were required by law to measure students on the basis of these skills, and the diploma of a student who did not achieve ninth-grade reading proficiency by the twelfth grade could be withheld. No such requirement was made in math or science.

The first draft of the essential guide for science is based on Project 2061 and is very process-oriented. It is more comprehensive than the three-page frameworks that were used previously.

Although there are essential skills documents, the state of Arizona does not put out curriculum guides.

The Arizona math curriculum specialist does not think that the state framework and new assessment has had an impact on course offerings yet; however, she thinks that they will soon. She believes that classes will have to be changed and restructured dramatically to promote the kind of higher level thinking needed.

Requirements. The state requires 20 credits for high school graduation, including at least two credits of math and two credits of science. Arizona universities require three years of science (including two years of lab science beyond the freshman level) and three years of math. The Arizona Board of Regents recently decided that Earth Science would no longer count as laboratory science. Since then, the number of Earth Science sections offered in the state decreased and the number of Biology sections increased substantially.

Textbooks. The state reviews science books for K-8. The state recommends certain textbooks, but districts have broad latitude when it comes to choosing which books will be used. However, they do pay attention to the state recommendations. Textbooks are reviewed by the state every six years and are selected using criteria such as relation to the state framework, pedagogy, themes, student outcomes, incorporation of technology, and the use of hands-on problem solving experiences. District textbook selection is not related to state funding.

Arizona - Large Urban District

This district utilizes a mix of top-down and bottom-up strategies to implement district and state policy objectives. Top-down authority is exercised through the selection of textbooks at the district level and implementation of a districtwide criterion referenced test. However, the district does encourage and support school site initiatives. For example, the district maintains an open campus policy, but one school experiencing difficulties with security was allowed to deviate from the districtwide policy and close the campus.

In addition, the district utilizes bottom-up strategies in the implementation of school site management and the use of teachers in developing district tests and curriculum guides. There is a tacit agreement between the district and the schools that, once the schools take initiative in improving quality, the district will work as hard as it can (lobbying, etc.) to improve the funding base and to support school site decisions.

The district has implemented a participatory management model and is in the fourth year of heavy investment in the implementation of the Effective Schools model. Each campus has a School Improvement Team, charged with overall operation of the school as it relates to student achievement. Each campus has an instructional committee that is an outgrowth of the teacher union handbook. Teachers feel that they have some decision making power, but it rests primarily in their ability to suggest alternatives to current policy, rather than to make decisions.

Some schools have instituted curriculum changes as a result of implementation of the Effective Schools model and School Improvement Team recommendations. These changes have occurred with the district's support, but not at the district's direction.

In addition to the Effective Schools initiative, the district is working to define achievement and develop indicators in all subject areas to ensure that schools are incorporating and integrating the state essential skills. They are also attempting to shift the district curriculum toward greater emphasis upon performance. At the district's initiative, all schools except one have eliminated General Math. In addition, each school has an advanced placement program.

The district is very cognizant of state mandates and has always maintained slightly higher standards than those required by the state.

Testing. State norm-referenced tests include a math section, but state testing in science is optional. The district also administers a series of criterion-referenced tests in science, math, reading, social studies, and writing for all high school grade levels. These tests were developed at the district level with the cooperation of teachers from around the district and in line with district curriculum guides and state essential skills. At the time of this study, implementation of this testing program had been underway for four years, and some of the tests were still under development. The tests are administered as pre- and posttests each semester (or four times per year) in all major courses. The district scores the tests for the schools and distributes results within a week, including a roster of the students in class, subtests and full test scores, scores by student, teacher, school, and district. The district is attempting to implement site-based scoring to reduce the turnaround time for test results even further.

Although the district would ideally like to revise these exams every year, the large number of tests makes this unfeasible (for example, tests are available for 23 math and 9 science classes, with additional instruments being devised to match the state essential skills). Emphasis on the importance of these tests varies from classroom to classroom since the district test is not generally tied to any consequences for students, such as grades. Teachers are encouraged to emphasize to students the importance of doing their best on the test, even though it may not affect their grades. Some teachers use the tests as final exams to ensure that students will work hard on them. However, it is district policy that the test cannot count for more than 20% of the final grade in a class. In general, the district's perception is that teachers are increasing the alignment between curriculum and the content of the tests.

The state tests, the results of which are published in the papers, have had the strongest effect on changes in the district. The state tests brought community pressure to bear on the district, since it has performed so poorly on the tests.

Efforts by the district to improve student performance on tests include:

- Creation of a districtwide Student Achievement Committee
- Implementation of Effective Schools model, which includes use of School

Improvement Teams on each campus.

- The district has asked that School Improvement Teams address new ways to implement test-taking strategies into the regular curriculum. Currently, teachers spend 10-20 minutes per day the two weeks before the test to go over how to take a test and the importance of tests. This is 8 percent of instructional time over this period. This change would make it an ongoing part of the curriculum and not just a pretest activity.

Student achievement in the district as measured by district criterion-referenced tests has improved. District scores have fallen on the state norm-referenced test, although they are staying on par on a national level.

Guides. State frameworks influence district policy in a number of ways. The district's curriculum guides and criterion-referenced tests are based on the state frameworks. Inservice training sponsored by the state tends to be more process-oriented, as are the state frameworks.

The district curriculum guides encompass the information in the state essential skills and are aligned with the district's criterion-referenced tests and, to the extent possible, to the state's norm-referenced test. When the state implements its criterion-referenced test, the curriculum guides will be amended to incorporate this material as well. Teachers are contractually obligated to follow the district curriculum guides.

Requirements. District requirements for graduation include two years of math and two years of science, including one year of lab science.

Textbooks. The district selects textbooks based on teacher recommendations; usually the district is willing to go along with whatever the teachers recommend. Textbooks are reviewed by the district on a 5-6 year cycle with committees of department chairs, teachers, and parents making recommendations to the board of education a year before the actual adoption. Nevertheless, the district allows for school-specific needs. For example, the two schools studied used a different math textbook than the other schools in the district due to the high proportion of at-risk students enrolled there.

Professional Development. The district offers both mandatory and voluntary workshops, some of which have focused on subject matter. In addition, schools can set up any professional development class as long as there is sufficient interest. The district is helping school administrators and teachers with the student achievement and success plan. They are providing technical assistance and informing them about the state essential skills in addition to putting together workshops.

Evaluation. The district has an elaborate teacher evaluation system in which all administrators have been trained (about ten hours). Teacher evaluations cover planning skills, instructional skills, student progress, management of instructional time and space, management of student behaviors, knowledge of subject matter, and professionalism.

Resources. The superintendent is very active in seeking funds for the district from numerous sources, including the state and local property taxes. A recently passed property tax override will generate approximately $6.5 million additional for the district. The district also receives a substantial amount of desegregation money.

The desegregation order was imposed in 1984. All but one of the schools in the district have met the level of integration required by the desegregation order. To comply, the district received permission to levy an increment to the property tax, which they used to create magnet programs in all the high schools. The state has to approve the increment, but so far it has approved all proposed increments. The district has parlayed this magnet money into an important source of revenue: $20 million out of a total budget of $70 million.

The state of Arizona is financially troubled and staff development is being cut due to budget problems. Schools are also reluctant to release teachers for inservice when budgets are tight.

Students. The district is more than 50% minority students. There has been a tremendous increase in Limited English Proficient (LEP) students, from 270 five years ago to 1,290 this year. It is projecting 1,600 next year, so it will have gone from less than 2 percent to 8 percent of the district student population. It currently has a small ESL program but is working to develop a bilingual program as well. This includes math and science. State reform may have increased the attention to LEP students, because a new categorical program that funds programs for LEP students was implemented in 1989-90. Districts are funded based on the number of students participating in LEP programs. The district has a compounding problem in that 25% of the student body changes each year due to in- and out-migration of students.

Enrollment has been declining in the district overall. One of the two high schools in our sample was an exception to the declining enrollments. That high school was growing by maintaining its residential enrollment base and attracting additional students through magnet programs. The district is losing about 200-400 students per year, it expects this trend to continue for two more years, when the enrollments should begin to climb, at a rate of approximately 200 students per year.

Placement. The district has largely eliminated its tracking system, with all students required to take freshman math and science. If students are unable to complete these courses, they are transferred into a remedial course, but in general, all students enroll in freshman algebra and biology.

District's Role. The district has implemented state frameworks by using these frameworks in the development of district curriculum guides and district criterion-referenced tests. The district's large criterion-referenced testing program was developed in response to state reliance on norm-referenced tests. The largely poor and minority district was repeatedly embarrassed by the publication of the results of these tests. The criterion-referenced pre- and posttests were created by the district to provide a measure of the successes of schools, teachers, and students, rather than allowing the public and school personnel to continue to focus on their relatively low standing in the state. This approach was also taken to buy some local support in the form of passage of property tax referenda.

National professional organizations influence teacher opinions about the importance of assessment, frameworks, and curriculum. The math and science curriculum guides will be rewritten next year and district staff and teachers are looking at the standards put out by professional organizations as a guide.

Arizona - Large Urban School (A1)

Overview. Responding to district and school leadership, and with the help of better preparation of students from feeder schools, A1 has upgraded its math and science curriculum, eliminating many sections of lower level science and math. The district has added an advanced placement curriculum and a summer school program that enables students to advance more quickly through the curriculum, taking higher level math and science courses in the summer. Despite the fact that these curriculum upgrading efforts were at the district's initiative, teachers and administrators credit much of the change over the last five to six years to the efforts of the past principal and dedicated teachers.

As a result of these efforts, most freshmen take biology, rather than general science, and algebra, rather than general math. This approach enables all students with the interest and aptitude to continue taking challenging, discipline-based math and science curriculum.

The state push to increase awareness about the state frameworks and assessment has prompted more participation from business and industry. At A1, the attention has raised student and teacher expectations. Students are responding by taking more courses beyond the two-year minimum math requirement.

Also at the district's initiative, school management involves School Improvement Teams who work together to identify and resolve problems.

Department Efforts. The department teachers work together to make decisions. The department chair brings the recommendation to the school for approval. The school has thus far been very supportive of departmental efforts. The curriculum is constantly being updated and revised.

However, the math department chair indicated that she feels she has very little power. For example, she has only recommendation power in scheduling. She describes her role as one of a conduit of information.

Testing. In math classes with two or more sections, teachers collaborate on semester exams. School improvement teams at A1 focus on ways to improve student achievement, and thus the curriculum focuses on test-taking strategies part of the year. Despite these efforts, the school is at or below the norm in terms of state testing.

Guides. A1 is attempting to align its curriculum with the state curriculum frameworks. Currently, however, if a student fulfills only the minimum math requirement, he/she may not have been exposed to all of the state's essential math skills. In order to master all the state essential skills, a student must begin with algebra. A1 is moving toward implementing this type of model, but there are currently some students starting with lower level math courses.

Textbooks. Once the individual schools have provided input to the district, the department chairs get together to decide what books will actually be selected. Each department chair lobbies for the books that his department wants.

Evaluation. Teachers at A1 are evaluated to determine whether lesson objectives are being followed. Each teacher must turn in a set of course objectives to the principal and send home a copy for parents to sign.

Math teachers at A1 are required to make one classroom visit each semester to another math teacher. The math department chair stressed the importance of this policy as a good way for teachers to learn from one another.

Resources. Department chairs control the budget for their respective departments. Departmental resources are described as insufficient to meet departmental objectives, particularly in science.

In addition, A1 is suffering from a shortage of science classrooms. Although they utilize travelling teachers and have remodeled several rooms to make best use of existing space, they are still short several rooms due to enrollment increases as a function of state increases in graduation requirements.

Students. The student population is 50% Hispanic, 22% African-American, and 28% Anglo. A1 is located in the least expensive part of town. Mobility rates are high, and there are a number of homeless students. According to the school counselor, these highly mobile students are often more familiar with failure than with success.

Although A1 has seen an increase in attendance and graduation rates and a decrease in the dropout rate over the last five to six years, the rates are still not acceptable. The absence rate is 12% and the dropout rate is 15-18%, down from 20%. Students are placed in a college bound or noncollege bound track. Initial placement usually determines what general direction a student will take, but students can take any class as long as they continue to succeed. Consistent with the district's press to eliminate tracking, the number of arithmetic review classes has dropped from twelve to two in ten years. Since all freshmen have begun to take algebra, the success rate has jumped from 10-20% to about 66%. Standardized test scores and 8th-grade recommendations determine initial math placement. However, teachers also make recommendations, and a parent can overrule the school's placement decision. The administration does not play a role in placement at A1. Seventy-five percent of the students never get to algebra 3-4, and 25% are in the regular college track.

The school counselor described his function of counseling students about which course to take like this: "We are sales people. I'm sitting there with an eighth grader looking at his test scores and he's saying 'Give me the easiest thing possible.' Then I say 'According to this test score you did wonderful, you did extremely well. You should be in Honors Algebra. My gracious you did well. Do you like math?' All of a sudden you see this little kid perking up. Somebody has complimented him and he is going, 'Oh, I have a functioning brain.'. . . That is how we register, having to convince kids that this is the right thing for them to do."

Counselors generally emphasize graduation requirements and try to work out a plan so that students are ready for either college or work. There are seven counselors for 2500 students.

To fulfill minimum graduation requirements for science, students can take Biology and Environmental Science or Earth Science. To go beyond the minimum requirement, students can take Biology, Chemistry, Physics, AP Biology 3-4, Anatomy and Physiology. The number of physics and chemistry classes at A1 has dramatically increased over the last nine years.

The math department is attempting to improve and enlarge its Calculus program; currently, only one section of Calculus is offered. Many upper level classes have been added because students are better prepared to take them. In addition, A1 has added an entire AP program as a result of the district's push for excellence.

In theory, students can move across tracks; however, the lock-step nature of the curriculum makes it difficult to move into a new sequence after the beginning of the freshmen year. The school counselor noted that one problem with the current system is that "if you don't succeed in a lock-step fashion, you end up playing catch-up, make-up, take-over, and a whole host of things that signify that you are a failure. That is not a good situation."

Restructuring. A1 is a computer science magnet school, and this has led to some difficulties with scheduling, especially with respect to honors classes. Five hundred students, including one hundred from outside of the district, have gone through the magnet program.

School Role. A1's administrators view the state policies as a starting point. However, the state requirement that students take two years of science and two years of math could be fulfilled by very low level math and science courses. Therefore, the school views its role (with the support and encouragement of the district) as going beyond the state requirements to prepare students for college and provide them with higher level skills. A1 is the only school in the district that still offers general math, but the trend is toward higher level courses.

Teachers indicated that they still have the freedom to teach whatever they feel is appropriate. However, they see this freedom declining as increased emphasis on testing and the development of new and better test instruments forces teachers to teach the material being tested. One science teacher expressed his concern about this trend: "I think it is detrimental because many times you teach a lot of things that . . . might not be on the state test but . . . might be a very important thing, such as venereal disease . . . or the use of drugs, you know. You may spend a lot more time on it than the state test would ever consider. Alcoholism is another one of our big problems with our students so we might spend . . . 2 or 3 weeks on . . . the use of alcohol and some of the problems that would be caused from it, some of the places that you could get help and things like that. But again that would not be on the state test, and therefore you're going to see us changing some of our disciplines in our classrooms just to teach towards the test in order to look like a good teacher."

In general, teachers viewed the new changes in state testing as less positive than school and district administrators. Still, at this point the effects of these changes can only be guessed.

Promising Practices. A1 is a pilot school for the freshman core approach in the district. Four teachers of math, science, and English are assigned total instructional responsibility for a group of ninety students.

A1 also offers a math summer advancement program that includes courses in Algebra 1-2, Algebra 3-4, Geometry/Trigonometry, Precalculus and Calculus. A student can advance an entire year by taking the course during the summer. The program intentionally does not include Prealgebra and General Math since the emphasis is on pushing students forward. The program is funded by the district.

Arizona - Large Urban School (A2)

Overview. A number of factors combine to make A2 a unique school. Both candidates for governor of Arizona proclaimed A2 a model school. The school has a dynamic principal and a very active School Improvement Team. The School Improvement Team's focus during 1990-91 was on instruction and learning. The previous year's focus was on creating a safe and orderly environment.

A2 has not always been a model. In previous years, A2 was extremely unsafe. The previous administration used to send problem employees to A2 in the hope that they would quit since the working conditions were so bad.

In general, the school philosophy has been well communicated to teachers and staff. The principal said, "At all our staff meetings, we begin with an overhead that says all students can learn. Our belief system is that success breeds success and that the schools control the conditions for that success. So we keep drilling that into them." Similarly, the counselor said, "If you have high expectations of the kids and they know that, and you're interested in teaching them . . . I believe you can bring the best out of kids." The principal pushes his teachers to come up with ideas that will improve student achievement and interest and stresses the need for high expectations.

The district supported the school by creating magnets and providing extra money to hire more teachers, thereby reducing the overall teaching load. Three years ago, A2 held summer workshops where teachers worked with consultants for five weeks to develop a vision for the school. Seventy new teachers were hired at a cost of roughly $2.7 million. Currently, teachers teach three to four classes per day and have the remainder of the day free for tutoring, curriculum development, home visits, or whatever other activities they deem appropriate.

School Efforts. The principal's philosophy of rewarding initiative among teachers means that departments can play a strong leadership role in the school. There is an instructional cabinet made up of department chairs through which they provide instructional leadership for the school.

At A2, all general math and science classes were eliminated at the initiative of the principal (and in concert with the philosophy of the district). All freshmen are required to take Algebra and ChemPhysics.

Although some teachers and students have had difficulty adjusting, overall the administration expects that the elimination of lower level courses will result in higher test scores and better prepared students. This shift to higher expectations is also illustrated by the implementation of an Algebra summer school.

The ChemPhysics course was created in response to teacher complaints that freshmen did not have a sufficient background or vocabulary in science. The year before our study was the pilot year for the program, and in the year of our study all freshmen were enrolled in ChemPhysics. The principal expressed his hope that enrollment of all freshmen in ChemPhysics would lead to increased enrollment in upper division science classes, with the long range goal being more physics classes. The number of chemistry classes has tripled over the last five years, and they expect to eventually have 8-10 classes of physics.

Testing. A2 administers the state norm-referenced test and the district criterion-referenced tests. Scores on state tests at A2 have been improving. One of the algebra teachers has used the district test as the final exam for her algebra class.

In addition, school administrators use scores from the district criterion-referenced tests to evaluate teacher performance and coverage of curriculum frameworks and objectives.

Text Adoption. As at A1, each department chair lobbies for the books that his department wants. Decisions are made at the district level by department chairs.

Professional Development. The principal at A2 is very supportive of teachers in terms of inservice opportunities. According to the principal, A2 has a very good staff development person who works well with administrators and teachers, giving them suggestions on how to improve performance.

According to the science department chair, A2 has the best working conditions of any school in the nation. The school has a lot of second career teachers with very good experience and over half of the science staff have advanced degrees.

Evaluation. At A2, administrators check whether a teacher is following district guidelines by looking at district test results and determining whether students are learning the objectives. In the science department, the department chair conducts his own informal evaluations by visiting classrooms, talking with teachers, and reviewing test scores.

Administrators supervise teachers to insure that they are in compliance with district guidelines, but they do not follow the district's elaborate teacher evaluation system.

Resources. A2 has a considerable amount of additional money from desegregation funds, which allows teachers to teach fewer classes, giving them more planning time and additional opportunities for professional development. The requirement that desegregation money be spent in specified ways means that the budget is rich in some areas and lacking in others, such as physical plant. A2 has set up work centers, with a computer and phone for each teacher.

Dollars are allocated to departments per student. Although a science department teacher complained about a lack of funds for laboratory materials, the principal feels that the budgets are adequate.

Students. A2 is in a low SES area, and many of the students lack motivation for academic pursuits. The majority are below grade level. The student population is 53.9% Hispanic, 30.3%

African-American, and 14.3% Anglo.

A2 used to lead the district in dropout and absence rates, but both statistics have improved in recent years.

Although there is a great deal of variability among ninth graders, the majority are not very well prepared. Teachers find it difficult to teach higher order thinking skills when students are having trouble with basic skills.

A2 receives five to six monolingual students from Mexico every day. Freshmen Newcomer Math helps them overcome language barriers. According to the math department chair, there is a need for similar upper level courses.

The counselor reported that about 50% of the A2 students matriculate to either a community college or university after graduation. The majority of these students go on to community college, with 12-15% going to a state or other university.

The science department chair believes that it is too early to tell whether changes have resulted in increased student achievement, especially since the district tests are constantly being revised. In four or five years, he expects to see improvement in ACT and SAT scores. However, the principal believes that student achievement is slowly going up and that test scores will skyrocket now that students are attending class. The failure rate has dropped from 48% to 30%.

Placement. Although teacher and counselor recommendations are offered, the ultimate decision about which class to take is left up to the student. Counselors encourage students to take higher level courses.

The math and science department chairs indicated that A2 is attempting to move away from tracking. All freshmen currently take Algebra, but some students receive Prealgebra or General Math credit depending on their performance. One observed math teacher separated three students from the regular class and taught them using a remedial textbook. All freshmen take ChemPhysics.

The hope is that with heterogeneous grouping more students will be reached, and science, reading, math and English skills will increase. However, there is some concern that not all students are benefitting from the heterogeneous grouping. "The question is whether all kids, especially kids that are kind of not in the middle, are benefiting from being in the heterogeneous group."

The math department chair indicated that he would like to change the placement mechanism and make finer distinctions among students so that teachers can better meet students' needs. He would like to promote the idea that learning is more important than time spent in school; the expectation that high school takes four years should be changed since all kids can learn, given enough time.

Restructuring. The district has been under a desegregation order for a number of years. By 1988, through the use of magnets, racial balancing had been accomplished in all the schools except for A2. The desegregation order had two major components: move students around in order to achieve a proper racial balance, and remedy the poor education that students were receiving.

A2 started a performing arts magnet and a visual arts magnet in an effort to reach compliance with the federal desegregation order. However, the poor reputation of the school in the community made it difficult to bring white students into the school despite the attractiveness of the magnet programs. The added magnet programs, ChemPhysics, and the Freshmen Core are all outgrowths of the desegregation order.

School Role. According to the principal, district administrators have been very supportive of school initiatives. The district has made a number of exceptions to district rules to accommodate the special needs at A2. For example, the district has an open campus policy, but allowed A2 to close its campus to improve school safety. A2 also has been granted an exemption by the district from a policy that allows teachers with seniority to select which classes they will teach. When teachers initially heard of the reduced teaching load, many wanted to come to A2. The coprincipal, however, did not want teachers unless they were excited and dedicated to teaching. Teachers can petition the principal or superintendent about assignment changes.

At A2, teachers are required by professional agreement to list their preferences and reasons for wanting to teach a particular class. The math department chair makes up the schedule of class assignments according to this agreement. The science department chair makes assignment recommendations for the science department to the assistant principal of registration. His recommendations are based on teacher preferences and school/student needs, with new teachers getting the leftover classes. Nevertheless, seniority does not play a major role.

Promising Practices. Like A1, A2 offers a Freshman Core, which is a math, science, English combination where teachers share a group of ninety students. The Core allows for more flexibility and creativity, as teachers can develop curriculum and scheduling together to benefit overall learning. Teachers participated in three years of summer workshops and received a 10% pay raise for participating in the program. The program has been successful for the most part, and the school is now in the process of trying to institutionalize it.

Arizona - Smaller Rural District

This is a single high school district, which was in the process of expanding to two high schools during our study. The size of the district means that many school personnel serve dual roles for the school and the district. For example, math and science department chairs also serve as district curriculum specialists. The lack of a district bureaucracy means that these individuals are the expert professionals in the district in their field, and the principal usually defers to their judgement in curricular matters.

At the same time, the district and the Board of Education take a hands-on approach to school policy. For example, the Board sets enrollment requirements for classes. In the case of one class, although a proposal for a new class was approved, an administrator did not like the new class and conveyed his dislike to a Board member. In the words of one teacher, "So even though the committee accepted it, it went through the Board. Then they played a little politics with how many students had to be in the classroom, and that did it. It basically killed it. That does happen occasionally."

The current emphasis is on incorporating computer usage into coursework and revising and upgrading the curriculum.

Guides. District administrators have used the state frameworks as a catalyst for change. According to one administrator, it was an "excuse to look at the curriculum in a larger context and take a hard look at where they want to go." For the most part, teachers are very aware of the state essential skills framework and support it.

The district is focusing on curriculum alignment with the state essential skills and the new state criterion-referenced test. A curriculum alignment committee, comprised of representatives from the five feeder schools and the high school, is working on aligning the elementary curriculum with the state essential skills and thus with high school curriculum. Some of the elementary schools offer an "Algebridge" program for eighth graders, allowing them to start with more advanced classes at the high school.

As standards have gone up, students have responded by taking harder courses. AP classes are offered in English, math, and science. Currently there are two sections of AP Physics.

Requirements. The district requires 22.5 credits for graduation (2.5 more than the state) and passage of the district math basic skills test. Students must have two years of science and two years of math to graduate.

Textbooks. The district selects textbooks with input from the teachers. Selection is related to the state essential skills framework; district textbook selection is not related to state funding.

Professional Development. Some of the teachers have gone back to school to take college algebra because of the district push for certification.

District administrators believe that the national attention on educational quality has led to more summer workshop opportunities for teachers. In addition, the budget for staff development has gone up by one-third, and many more teachers are interested in improving their knowledge.

The district science curriculum specialist (who is also the Science Department chair) has encouraged staff to participate in staff development activities: "I told my teachers that if they wanted promotions or better classrooms or different situations, they would have to sign up for NSF improvement workshops of some kind or another to show me they were interested in science. . ." As a result, the chemistry teachers spend almost every summer attending inservices.

Resources. The small size of the district enables it to maintain a decentralized budget process in which department chairs control the budget and teachers ask for what they need. Although they could use more money, there are no severe shortages.

Students. The district has students of high and very low SES and ability. The characteristics of the student population have been changing in recent years. Formerly, it was a rural district consisting predominantly of students from high SES families. However, the population in the area has grown in recent years, with larger numbers of low income students.

District personnel stated that recently feeder schools have been better preparing students and students are rising to the district and school's challenge of higher expectations.

Arizona - Smaller Rural School (A3)

Overview. Because the district is so small, it is in some cases somewhat arbitrary to make a district versus school level distinction. The discussion of school level strategy and interpretation of district level policy should be read with this in mind.

The current emphasis at A3 is on increasing computer usage and improving the curriculum. A3 holds periodic strategic planning meetings. A five-year plan was developed in the summer of 1988, and follow-up meetings were held in 1989 and 1990 to evaluate the progress.

Criticism by the school board that there was a huge gap between lower and upper track students and that students were lacking in basic skills when entering A3 led to opening of the channels of communication with feeder schools.

In addition, A3 added lower level chemistry (ChemCom, which is environmental chemistry) and Conceptual Physics classes in an attempt to bridge the gap between upper and lower level courses. The objective of ChemCom and Conceptual Physics is to be easy enough yet enlightening enough so that students will develop an interest in the subject and be motivated to enroll in upper level science classes. Physics enrollment has grown since the introduction of Conceptual Physics. Teachers are heavily involved in the development of these classes.

A3 is also trying to encourage students to take more challenging classes. Three years ago, most students would take General and Consumer Math to fulfill the graduation requirement. Now, only about 35-40% of students take General Math. In addition, more students are enrolled in upper level classes like Algebra 3-4 (120 out of 500 juniors).

AP classes are offered in English, math, and science. Currently there are two sections of AP physics.

A3 is a teacher-centered school. A curriculum committee of department chairs makes decisions for both the school and the district. According to the vice principal, the only changes in policy have been those that were initiated by teachers. The advent of new electives at A3 illustrates the interest that teachers have had in developing new courses and looking in new directions.

Although department chairs have a lot of power, teachers can bring proposals for new courses to the department chairs who present them to a district committee. In addition, teachers have a great deal of autonomy concerning content.

Testing. A3 requires students to take a teacher-designed district math competency test, the Math Basic Skills test.

Guides. According to the math department chair, district guidelines and outcomes determine curriculum content.

Graduation Requirements. Although the district does not require any math or science courses in addition to the state requirement, A3 has attempted to improve the lower end science sequence by adding ChemCom and Conceptual Physics classes in response to a School Board initiative.

As teachers have increased standards and raised the level of the material taught, students have responded by taking harder courses.

Textbooks. Textbooks are selected by a committee of teachers at A3. Selection is related to the state essential skills framework and the district/school strategic plan. However, according to the math department chair, while department chairs have some input concerning textbook selection, final selection is a district decision.

Professional Development. A3 holds inservices that focus on classroom management and teaching techniques.

A3 also has a voluntary district program whereby teachers observe each other and make suggestions. Partly due to the fact that it is not an evaluation, the program is well received by teachers as a good opportunity to see oneself through someone else's eyes.

For the last five years, the science department at A3 has been working on the development of the science curriculum during the summer. They have spent blocks of two or three days to two weeks working on curriculum development.

Evaluation. Teachers are formally evaluated annually at A3. The principal conducts the evaluation for the first three years. After that, the principal, associate principal, and department chair alternate years.

Resources. A3 has a very decentralized budget process. Department chairs control the budget and teachers ask for what they need. Although the school could use more money, there are no severe shortages. The school receives an increment or decrement from the previous year's budget depending on the availability of district funds.

The average size of a chemistry class has risen to 33, a level that the department chair feels is too high for effective instruction.

Students. The population at A3 is 51% Hispanic, a large percentage of whom are children of migrant workers. According to the science department chair, Hispanic students are just as talented and probably more creative than the Caucasian students but have lower self-esteem and are less motivated. Some of the students at A3 are the first in their families to go to high school.

Approximately 17% of the Hispanics from A3 go on to study at a university; most do well once they get there. Overall, 10% of the students go on to a four-year college and 25% to a two-year college.

Placement. For both math and science, students are placed according to teacher recommendations and the results of the math basic skills test, which is a teacher-developed algebra test. A lot of shuffling takes place in the first three to four weeks of school to ensure that students are correctly placed.

Prior grades and teacher recommendations are used in placement decisions after the freshman level. A student cannot take a higher science class than math class during the freshman year: Intro to Algebra students can only take General Science.

The tracking system has been refined in recent years, with attempts to disguise the college prep/non-college prep distinctions by calling them subject distinctions instead. There are three tracks at the freshman level, with some increase in movement across tracks since the rewriting of the strategic plan. Math and science are heavily tracked, but there is no longer a high level of correlation of tracks across subject area.

A3 has an Algebridge program at some of the feeder elementary schools. It allows eighth graders to take algebra so that, when they get to A3, they can start with more advanced algebra or geometry.

Restructuring. A3 has an engineering/science/math program for minority students that emphasizes test taking and study skills. Many of these students also participate in Upward Bound.

School Role. According to the vice principal (who is also a district administrator), district administrators have been very supportive of teachers.

California

The state of California views its role as building professional consensus on curriculum and promoting and implementing that consensus. State curriculum frameworks clarify what it is that all students should know. State department of instruction staff bring the state superintendent's implied energy and constitutional stature along with their own expertise and credibility to educational issues.

Over the past 10 years, California has been aggressive in its attempts to reform every curriculum area. Within this effort, English, mathematics, science, and history have been the focal points of attention and activity. In particular, California has an ambitious strategy for improving math and science education. The strategy involves five components: focus on curriculum issues; establish standards through professional consensus; promulgate curriculum frameworks; develop and use statewide assessments; and seek to influence the agendas of other national, state, and professional organizations regarding math and science education.

Due to the strong tradition of local control and declining state resources, the state is also attempting to influence classroom practice by influencing the agendas of other state and quasi-state or professional organizations that affect math and science education.

Testing. California has put considerable energy and time into the development of better assessment mechanisms. The state is moving from multiple-choice instruments toward performance tasks and open-ended responses. In mathematics, for example, the state is developing new modes of assessment that include free-response questions, investigations, and portfolios. At the time of our study, California tested at grades 3, 6, 8, and 12. Matrix sampling was used so that results could only be reported on a school basis; individual student scores were not reported. At grade 12, math was tested but not science. Since our study, testing was discontinued but is to begin again. Future tests will report scores at the student level, be performance based, occur at grades 4/5, 8, and 10 in four subject areas: language arts, math, science, and social studies (in grade 4, only math and language arts and in grade 5 only science and social studies).

Frameworks. The central vehicle for defining and disseminating the core curriculum is the state frameworks. Although these subject-specific curriculum frameworks have existed for a number of years, the nature of the frameworks changed during the 1980s. In 1984, following a back-to-the-basics measurement of instructional objectives in the 1970s, the state was defining long lists of isolated instructional objectives--almost 600 of them for science.

The 1985 math framework foreshadowed the NCTM *Standards* in 1989 and has most recently been revised to be even more tightly aligned to the NCTM *Standards*. The 1990 science framework consists of 40 major ideas and is rendered in a narrative style. The narrative style and many of the major ideas in the California framework are based on the national Project 2061 report Science for All Americans. Thus, the California framework is linked to a national and professional effort to define a core science curriculum, which in turn is related to other states' frameworks.

The frameworks provide leverage over instructional programs in the state because they are used to define the adoption of K-8 instructional materials. In addition, the new frameworks talk about assessment, staff development, and other leverage points in the system. Thus, while districts are not required to follow the frameworks, the state nevertheless adopts materials for programs that are consistent with the frameworks and intends to test each student using assessment instruments that are keyed to the frameworks.

The alignment of frameworks and assessments indicates to district and school personnel that the state is serious about the framework. The new assessment also provides the state enormous staff development as the state trains teachers to implement and evaluate the new system.

Requirements. In 1985, the California State University, for the first time, adopted subject-specific admissions requirements. These included four years of English; three years of mathematics; two years of foreign language; one year each of U.S. history, lab science, and visual and performing arts; and three years of approved electives. Similarly, the University of California requires four years of English, three years of mathematics, two years of the same foreign language, one year each of lab science and U.S. history, and four years of approved electives. Thus, curricular requirements for entrance to the University of California and the California State University are now virtually identical, though the missions and clientele of the two institutions are traditionally different. In total, the assumption behind the requirements is that students will learn more if they are exposed to broader academic content. In 1987 the state, for the first time, required two years of mathematics and two years of science for high school graduation.

Textbooks. The California State Board of Education periodically reviews texts and "adopts" a short list in each subject area. The state thus establishes stringent guidelines for choosing a book, then provides districts with a choice of several texts from which each district selects one. The state's adoption is tied to promulgation of curriculum frameworks. It is possible, though unlikely to be successful, that a district can opt not to choose any of the books on the state's list by requesting a waiver on a particular book that the district prefers. However, this much publicized California textbook adoption policy applies only to grades K-8 and so has no direct influence on high school mathematics and science curriculum content.

Professional Development. The state provides very little staff development itself. One reason for this is the political culture of the state. In effect, California is a local control state. Funds are distributed to districts on a formula basis with broad latitude over how they should be spent. State staff believe that almost all this money is allocated to teacher salaries. In any given year, there are several staff development, teacher preparation or new teacher support projects, but almost all of them are small, experimental projects and none persists. This leaves the state to rely heavily on the university-based subject matter projects, for example, the California Mathematics Project with an annual budget of only $1.5 million.

Another reason for the state's limited direct role in staff development is that there is no state money going through the department for mathematics or science curriculum. The last three years of budget traumas and political turmoil between the state superintendent and former governor practically eliminated the department's funding base.

The state does have some influence over significant amounts of federal money that can be used for staff development. The Eisenhower program is a federal math and science teacher training program providing approximately $15 million annually. The biggest part of these funds goes directly to districts, allocated on a per-capita basis for math and science teacher training. The state does not exercise much leverage over the use of these funds, but it can and does require districts to state in their applications the extent to which they plan to provide teacher training that is consistent with the state frameworks.

State department staff feel that they get quite a bit of leverage out of discretionary monies. For example, they support projects that develop the kinds of instructional materials needed in math and science, and they support the development of mentor teachers and teacher leaders. In science, this effort is quite explicit in a project called California Science Improvement Network. Another such effort is the Scope, Sequence, and Coordination Project in which several hundred middle and high schools are attempting to transform the high school curriculum.

The best example of state involvement in professional development in this study is the training California teachers receive to prepare them to teach Math A. Math A is a teacher-designed but state-promoted course for students who might otherwise have taken ninth-grade general mathematics, a program of study that will bridge them into more advanced courses in subsequent years. The course may be offered at the discretion of the district or school. The state provides a 5-day summer inservice for all new Math A teachers. Several local sites have extended the state's leadership in staff development to teach Math A by increasing the summer program to four weeks and adding inservices during the academic year. Math A is described further in the promising practices section of this report.

California - Large Urban District

The district views its role as facilitator of changes in curriculum policy, utilizing testing and curriculum guides to shape school curriculum. Through the development of optional mastery tests and curriculum guides that are aligned with the state frameworks, the district facilitates and encourages alignment of practice with the state frameworks. The mastery tests are used in evaluation of curriculum and teacher performance. Current district leadership is less interested in testing than the previous superintendent.

In science, Project 2061 has influenced the kinds of projects and courses the district produces in the same way that the state framework has heavily influenced the district. Professional organizations, like AAAS, foster agreement among teachers in the direction the curriculum should be taken.

Testing. The district administers a number of state and district testing instruments, including the California Assessment Program, the Golden State Exam, and the college assessment program. Though they have since been discontinued, the district had developed five mastery tests in math (a sixth for Math A was under development) and four science mastery tests (e.g., physical, earth, general, and living systems/human biology with a fifth under development). The mastery tests were used in program evaluation, to help align the curriculum, and to gain consistency across the district on the district's core objectives.

On a voluntary basis, teachers served on committees to develop the mastery tests. The district facilitated development by sending teachers to various training sessions and conferences on test development skills. The tests were intended to be revised periodically as needed. These mastery tests did not play a role in student placement, and use of the tests was voluntary.

Guides. The district has a strong commitment to implementing both math and science state curriculum frameworks. The state has provided a framework that is philosophical in nature, followed by an addendum that specifies content and model curriculum guides that demonstrate implementation. The new frameworks focus on process, organization, and instructional strategies more than content. In math, the district has incorporated Math A into its curriculum. In science, courses have been revised to incorporate a broader view of science.

There is a districtwide curriculum that establishes courses each school must offer. Other courses depend on student interest and teacher initiative but are required to have a minimum enrollment. Examples of school-initiated courses include astronomy and marine biology.

Each teacher receives a district curriculum guide. The new superintendent wants to move toward the state frameworks that were not used by the former superintendent. The current (district) course outlines are approximately four pages long and are "pretty general."

The district has course guides, approximately four pages each, that describe the goals of the course and objectives to be reached, an evaluation strategy, and a description of course activities. Past curriculum offerings differed among schools in the district. There are district objectives written for every course, and there are specific goals for every course. The course guides are developed by instructional policy committees that are organized by subject area and composed of all department chairs and the district subject area coordinator. Department chairs have a strong leadership role in curriculum development through this committee, which is the primary decision making body in the district regarding curriculum.

In addition, departments are free to develop their own projects. Teachers feel they have a major say in structuring of curriculum through the development of these projects. Eventually the projects come before an instructional policy committee to ensure that what they are doing is compatible with the general flow of the science or math curriculum development in the district.

Requirements. The graduation requirements are identical to the state's, two years of science and two years of math. In science, the old framework required one year of physical science and one year of biological science. The new framework is oriented toward an integrated science program cutting across the classical lines of biology, chemistry, and physics. As a result, the district has recently changed its science graduation requirement to require two years of science that include biological and physical science concepts.

In math, General Math sections have decreased, whether Math A sections have increased. The district has no statistics yet on whether Algebra I, Geometry, or Algebra II sections have increased: "We're not sure if that's our goal."

Textbooks. The need for new books is documented in district one-year and five-year plans. Teachers meet with the textbook evaluation committee. New books are pilot-tested by three teachers in different schools in the district, with final adoption the responsibility of the instructional policy committees with approval by the school board. Textbooks are selected to match course objectives.

Professional Development. In science, the district has an inservice training program with a number of days set aside during the school year for training. The first round of inservices was devoted to generic teaching techniques. Now the district is moving more toward subject matter, and this is going to be handled at the school sites with guidance from the district. Training programs are developed by district subject area coordinators and department chairs based on their assessment of what needs exist among the teaching staff. The district finds that an increasingly larger percentage of the science teachers are interested and want to become involved in retraining.

There are both district and school inservice calendars. A school's calendar may or may not coincide with that of other schools, so teachers across schools may or may not have an opportunity to meet together. Beginning in 1989-90, the district provides three days of inservice. These days are in addition to six days provided by schools, for a total of nine inservice days during the school year. These programs are part of the work day for teachers, thus all teachers are expected to attend.

In math, workshops are offered once a semester and once during the summer, all focusing on methodology associated with teaching math, using manipulatives, calculators, and explorations. Each workshop program runs six days during the academic year from one to four o'clock and for two days during the summer. The goal is that all the math teachers will cycle through the inservice curriculum. The district stopped working on math content in staff development programs about four or five years ago. "We found that content wasn't our problem. As things started shifting, the problem was methodologies, calculators, computers, manipulatives, and how we can change what is occurring in the classroom with methodology."

The district uses $20,000 in Eisenhower funds for inservice training to prepare teachers for new courses.

Resources. The district experienced considerable problems when a large number of new science teachers were hired as a result of the increase in the science graduation requirement. The district offered a variety of minicourses from different district and college sources, and the staff capabilities have substantially improved as a result.

In math, district administrators said that about 80 percent of teachers have the skills necessary to teach their courses. The remaining 20 percent are teachers who have come to math from other subject areas—industrial arts, home economics, physical education, and electives. Of the 80 percent who are qualified, about 80 percent again have math majors or minors.

The district lacks sufficient funds to purchase materials for new courses such as Math A and Math B (e.g., calculators and manipulatives). In addition, the increase in science graduation requirements has caused class size to increase; there are insufficient funds to hire additional teachers.

Students. The student population comes primarily from low socioeconomic status families, with low levels of parental education. Many are from broken homes. A large number of students are achieving below grade level. The district has an unmet need for bilingual teachers.

The district is getting an increase in the numbers of really strong students, but the overall distribution regarding student performance is bimodal. The district's goal is that more students go on to postsecondary education.

Placement. The district has an extensive tracking program, with two main tracks, and a number of subdivisions within the lower track. However, district administrators are actively pursuing a strategy of eliminating tracking in science and math programs. Pilot programs are in place to eliminate tracking in math.

In science, the college prep track includes biology, chemistry, physics, physiology, and some honors courses in these areas. The general science track has semester-long courses in human biology, living systems, earth science, and physical science. In addition, there are some specialty courses offered as electives in the district. These include, for example, ecology, marine biology, and astronomy. Students can be moved from one track to the other depending upon their readiness.

In contrast to science, there is very little movement between tracks in math. Math A, a new course encouraged by the state, is an attempt to provide a bridge between the tracks. It is replacing introduction to algebra; it could be replacing low level math courses altogether. To the extent that Math A uses an integrated curriculum, it is a detracked concept. It's the district's "first attempt at trying to detrack within a track . . . but we're still a long way from nontracking."

A recent accreditation review rated two district high schools low because of math tracking and failure to implement math frameworks. The district plans to develop new tests in math and hopes to use federal Eisenhower dollars for staff development.

Restructuring. The district is responding to pressure from the state to enroll students in more academic classes. The emphasis is on access, that is, getting the students into classes. At the same time, the district is moving toward a site-based decision making model. Intervention or changes occur more on a school-level basis.

In science, the graduation requirement change from one to two years had a large impact. According to the science area coordinator, "We found our department increased not just to accommodate those students who had then to get the two years to graduate from high school, but we found that students who might otherwise have been satisfied with two years of science now perceive science as being more important and take three or four years of science. And so the numbers of students that are college bound tend to include more science in their high school experience."

District Role. The district relies heavily on state frameworks. In science, for example, the district is redefining its entire science curriculum to adjust to what it sees as coming changes in the soon-to-be-published new science framework. One high school in this study is part of a state 100 Schools Project. Participating schools receive state funds to experiment with new approaches to delivering the type of science curriculum outlined in the state's new science framework. The science coordinator reported that increased state graduation requirements in science have, in the last few years, had the biggest impact on district and classroom programs, but that, if asked the same question a few years from now, the answer will be that the new framework had the biggest impact.

In math, the opposite is true. The state frameworks have played a "big" role by starting the process of replacing introduction to algebra with Math A, which opened a whole examination of the noncollege-bound curriculum. The math graduation requirements have remained at two years for at least a decade.

The math coordinator reported that she feels placed in the middle between the state and the teachers, especially recently: "It's been an okay position for me. I'm a strong believer in the direction the state's going, so I'm having a really easy time carrying the message. But the message isn't being received as easily as I would hope. So it's a constant battle."

The effect of all this change on math teachers was described as positive. "There are a lot of things going on in the district that weren't going on five years ago. There are a lot of things being talked about. Five years ago we taught 50 percent of our kids out of a packet-based computation curriculum, and we've moved way far away from that."

And "the teachers are changing. Anybody who's been involved in Math A, you'll find those methodologies and things being brought into their Algebra I classes." The new techniques are "trickling slowly" into other parts of these teachers' courses. They are not trickling throughout the departments, however, as some teachers are resisting the changes.

California - Large Urban School (C1)

The principal passes on district curriculum recommendations to the teaching staff, but also stresses that department and teacher initiatives are welcomed. For example, the new science approach (FAST) was initiated by a teacher who attended a science teachers convention and applied for a state science restructuring grant to integrate science. This high school hopes to involve the feeder junior highs in FAST, but the lead teacher has taken a leave of absence to continue his education.

Testing. Teachers have the option of using mastery tests developed at the district level. However, there appears to be little classroom support for the district's mastery tests so the impact from these tests on the curriculum is minimal.

Although the school prides itself on its huge array of choices and specialized courses, school staff indicated concern that there are not enough courses with practical applications and kids often are uninterested in the standard sequences.

Evaluation. The current teacher evaluation cycle is two years and concentrates on pedagogy rather than content. However, if the department chair notices a big problem, there may be some types of content review.

Resources. Instructional materials are described as adequate within a climate of low expectations. The school gets $750,000 in categorical grants and uses these to support school needs.

Students. Students are predominantly from lower middle class families; the school is located in a Hispanic ghetto. The student population includes white, 23.2%; black, 7.3%; Hispanic, 29.9%; Native American, 0.9%; Chinese, 6.1%; Filipino, 13.1%; Southeast Asian, 1.6%; Vietnamese, 12.1%; other Asian, 5.8%.

During the past few years, enrollments have shifted from a school where Anglo students were the dominant group with many Hispanic and few Asian students to a situation now where Asians are the dominant group with many Hispanics and few Anglos.

Placement. The school has added a freshman dropout prevention class. Thus far, there has been no increase in the dropout rate due to increased graduation requirements.

Interest in math and science courses is up in part because of the school's proximity to Silicon Valley, the growth in the Asian student population, and increased computer awareness. There are numerous ESL sheltered courses. The school reports a slight upward trend in advanced math/science classes–including 17 physics AP and five calculus AP.

Students are tracked based on entering placement tests in math and English, grades in junior high school, and teacher recommendations. However, the school is moving toward eliminating tracking as a long-term goal. Currently, students can switch tracks in math and science primarily through adult education or summer school.

About 1,000 students enter the school each year–this results in 20 sections of General Science for noncollege bound students and 27 sections of Introduction to Science for college bound students. Some students go from General Science to Introduction to Biology, but not many. Approximately 10 high level students per year go directly into Biology.

The math college-bound sequence includes Algebra I, Geometry, Algebra II, Trigonometry, and Calculus. The math noncollege bound sequence includes Math 1 (remedial), Math A, and Accounting or Consumer Math.

A college-bound science sequence might include Introduction to Science, Biology, Physics, and Chemistry, with electives of Astronomy and Marine Biology. A noncollege science sequence might include General Science and Introduction to Science, with electives of Cosmetology, Electronics, or Home Economics. The possible bridge courses are Math A and Introduction to Science.

The school has introduced courses in computer literacy and has a state technology grant to incorporate computers in the math curriculum.

California - Large Urban School (C2)

The school attempts to balance directives from the state and the district with student needs. The vice principal indicated that there is a tremendous commitment from the district to improve the math and science program. A few years earlier, however, school administrators reviewed the master schedule and found a number of advanced courses but also an "absurd" number of Ds and Fs in those courses.

> So we kind of did a philosophical change there saying that forcing people into places where they don't belong isn't maybe the answer. We probably went down in a few of those advanced courses for maybe the first year, but we're back up to three physics, six chemistry, and two calculus. . . . I think standards are as high as they have always been. Do they have the prerequisites to get into the higher courses? If not, backtrack a little and get them strengthened and focused in the prerequisites.

Guides. At the school level, the vice principal meets with department chairs in January or February of each year to discuss the curriculum that exists in the district and what those at the school would like to offer, given existing expertise on the staff. Department chairs meet with the district subject area coordinators monthly. All basic curriculum decisions are made at these meetings.

Evaluation. Experienced Teachers are evaluated every other year; new teachers, every year. Whether or not course objectives are met sometimes becomes part of the evaluation. Teachers are not observed as part of their evaluation; lesson plans are required only if the administration detects incompetence.

The district mastery tests are used to evaluate curriculum--whether course objectives are being met--not to evaluate teachers.

Resources. Five schools receive Chapter 1 money in the district and this school is ranked number six in need. They have a population of students that could benefit from those resources.

The school does not receive School Improvement Program money from the state.

The principal makes up a budget department by department, based on the number of members of each department and the number of students the department serves. There is faculty input on what the needs are, but school administrators indicated that funds were insufficient to meet the needs, especially computing needs.

Students. Students are from lower middle socioeconomic backgrounds from a wide range of ethnic groups. School administrators indicated that, because of their impoverished background, many students suffer from low self-esteem, and need constant encouragement.

Teachers and administrators indicated that there is little parent involvement in school. "This is a poorer area, on the wrong side of the tracks, and to help [the students] see goals that are beyond those is a terribly difficult task. To say that you're not successful is not to say that you're not trying. There is some accuracy to the statement that there is little reinforcement at home for the idea of college."

For a while, with a large influx of Asian students, math achievement test scores went up and verbal scores went down. "The big push now is to have more students take [the SAT], and the result of that is scores have either gone down slightly or pretty much held at the same level. Ours have been pretty consistent."

The school has more ESL classes than ever before. According to the vice principal, "We started out with seven ESL kids speaking no English at the start of the year and a month later we were up to 40. And we didn't have resources, we didn't have teachers, we didn't have anything. About half of these kids are from Mexico, the other half from Asia."

One teacher described the cultural differences among his students' families and how that impacted on their involvement, namely, that Anglo parents called to talk about what was happening in class, sometimes Vietnamese, but never Hispanic or Cambodian parents.

The counselor reported that "all the students in the school say that they want to go to college. They know that's the right answer when someone asks them about their plans. In effect, the students know that that's not really what they want to do, but it's what they're supposed to want to do--it's what the system wants to hear, so it's what they say. In fact, about 20 percent of the student body is headed for four-year colleges." All the counselors are encouraging kids to attend college, where they didn't in the past.

Placement. The school tracks students based primarily on teacher recommendations. There is movement between tracks based on student motivation and performance.

The counselor's bias is that a student needs more math than science in order to succeed.

School Role. The math curriculum is changing now because of state mandated frameworks. The mandate is to move into manipulatives and critical thinking skills and away from rote memorization. In the last three years, the district has introduced Math A and B into the curriculum, which at this school has virtually replaced introduction to algebra (down from 10 to 3 sections). The vice principal said, "I feel fairly good about [the introduction of Math A and B] because there are some schools in the district with staff refusing to teach it. And they're going back to the old algebra type thing. It's taking time, but our staff seems to be willing to go to workshops and get the training. The problem here is no books, so you're forever running off worksheets and that type of thing. And it's a drain on everybody. The state puts out its framework and then it's up to us to put it in place. They don't give us all the books and tell us what to do.

Some changes in math and science are being driven by state testing. For example, last year the California Assessment Program incorporated critical thinking items on the state test. The district did poorly. According to the vice principal, "I think everybody was realizing, first of all, if you're going to be tested on critical thinking as part of your curriculum, you had better get it in your curriculum. I think that's what's happening. And the fact is that, yes, you probably should have been teaching it all along anyway."

One teacher described the changes in his and others' teaching that has been brought on by changes in the state frameworks and district guidelines as "dramatic," but not without consequences: "A lot of teachers just don't understand why we have to make all the changes. Are we supposed to throw out the way we've been teaching for 20 years?" Similarly, a problem has arisen because of the perceived mismatch between new methodologies and student abilities to handle these methods, e.g., the kids in Math A are too immature to handle the cooperative learning and manipulatives used in that course. This has adversely affected teacher morale because some teachers feel they are being forced to change in ways that they are uncomfortable with, and as a result will be less effective. The feeling that Math A has been forced on the entire state is at the root of much of the dissatisfaction.

California - Smaller Rural District

The district influences school policy through the development of curriculum guidelines that are aligned with state frameworks and tests. The district includes teachers and department chairs in curriculum development. Recent district efforts have concentrated on articulation of high school curriculum with elementary and junior high schools, to improve preparation of students.

Testing. The district administers the California Assessment Program (CAP) and the CTBS test. The CAP test includes a math component at the twelfth-grade level. CTBS is administered in all grade levels. There are no district tests in math or science. District administrators attempt to align teaching in math to what is tested in the CAP.

Guides. The district distributes both state frameworks and district curriculum guides to teachers. Curriculum guides are reviewed periodically for alignment to the state frameworks, but district administrators expressed concern that the state framework changes so rapidly, it is difficult to incorporate all the changes into the curriculum. District-level frameworks are revised the year following the year that the state-level frameworks are published.

The curriculum coordinator chairs the curriculum committees that develop the district scope and sequence and course descriptions at the secondary level. The curriculum coordinator also chairs the committee that handles articulation from elementary to secondary schools, materials adoption, textbook adoption, and coordination of staff development.

Requirements. The district graduation requirements are the same as the state, two years each of math and science. The district is encouraging students to take a third year of math and is in the process of changing its science graduation requirement to three years, to take effect in 1992.

Textbooks. The district selects its textbooks after the district scope and sequence is developed. As was mentioned previously, the district scope and sequence is aligned with the state framework, so the textbooks are, in effect, selected to match the state framework. The textbook adoption committee consists of teachers and district staff.

Professional Development. In the past, professional development in the district included voluntary workshops developed by mentor teachers in math and science. Approximately half of the teachers participated in these workshops. However, the workshops are no longer offered in math and science because district resources are being directed to other subject areas, depending on which subjects are up in the framework-adoption cycle.

The schools attempt to hold two inservices a year, which are mandatory because they are offered on staff development days. In addition, voluntary summer programs are offered. Approximately 50 percent of the secondary science teachers have received training in the new frameworks. The curriculum coordinator could not recall any math teachers being trained at the secondary level.

The curriculum coordinator indicated that teachers lacked the background to teach advanced math and science.

Resources. District resources are somewhat scarce. The district would like to take students to science museums, such as the Children's Exploratorium or bring in experts from nearby institutions. "Those are the kinds of things that I think really enhance the science program and spark the interest. That's where you really get the kids turned on about math and science." However, the district is unable to make these arrangements because of their cost. "We need the money to transport [kids], not just train teachers."

Placement. Math and science are tracked, but the district has, for three years, been trying to eliminate tracking and move to heterogeneous grouping.

District Role. District administrators indicated that the state curriculum frameworks have had tremendous impact on math and science curriculum by initiating a shift away from an emphasis on computation and toward more application and problem solving. In addition, the district has, as a result of state initiatives, begun to encourage students to take more than the minimum two years of math and science.

Administrators believe the new frameworks and books have changed both what and how teachers teach. Mostly the change can be noted in how teachers teach—much more hands-on activities, especially in the beginning high school courses. For example, the prior emphasis was on recitation and drill. Now the emphasis is on hands-on activities and activities that relate to higher level thinking skills.

California - Smaller Rural School (C3)

The school is decentralized, with departments maintaining a high degree of autonomy. It is the school's (and district's) philosophy that teachers take ownership in curricular decisions. The school administration raises issues and tries to encourage the departments to go in a particular direction, but they let the teachers make the decisions as a department. The administrators support the decision making process by providing data, information, opportunities to go to other schools for observations, etc.

The departments make decisions about the courses offered. For example, several years ago the school offered a "Math 1A and Math 1B" course sequence that was watered down prealgebra. With encouragement from the administrators, the department examined the course offerings and decided to eliminate Math 1A and Math 1B and replace them with a sequence called Mastery Math.

Now that mastery math has been around for several years, the administration doesn't like it and would like to see a better prealgebra class offered. The administration raises the issue by presenting data to the department on the course taking patterns and achievement of students taking mastery math that shows that many of these students are not going on to college prep math courses.

The administrators of this school and district are very interested in national messages about science and math education. School administrators as well as many of the teachers keep up with the professional journals to learn about the latest research and practice.

Testing. The school has mastery tests in math that determine whether or not students can take the next level math class. For example, students must demonstrate proficiency in mastery math before enrolling in higher level courses such as algebra. These tests were created by the math department and are not required by or reported to the district.

Guides. The school administration makes sure that the departments have copies of the state and district frameworks, but these frameworks serve primarily as references. As whole departments, teachers develop more detailed curricula for the courses offered.

Textbooks. Textbook decisions are presented to and formally approved by the school board, but the departments are seen as responsible for making the decisions.

Evaluation. There is no formal process for evaluating whether or not course objectives are being met. There are no observations, evaluation forms, or submission of lesson plans for this purpose.

Resources. Regarding decisions about teaching materials and supplies, each department presents a proposed budget to the principal that itemizes the materials that the department wants to purchase with its allocation of school materials budget. Thus, the department decides as a group how such funds should be spent.

The vice principal feels that there are insufficient funds available for the purchase of supplies and materials. For example, the school has purchased about 15 computers and does not have the money to buy any more. They would like to have enough to set up a center where there would be enough computers for a class to come in and have each student at a computer. As a result, the computers currently are not being used.

In general, the school gets very little money from the district for supplies and equipment. Most of the major items that the school purchases are funded by grant money. The science department is using a $30,000 grant to update all of the lab equipment.

Math teachers reported that basic materials were sufficient, though many buy supplies on their own, saying that this is easier than submitting a request or attempting to be reimbursed. The shortcoming in math arises in the lack of computers and other technology that could enhance classroom instruction.

Science teachers also reported that the basic materials were sufficient, but resources were scarce. Teachers reported that they would like more models and devices that could catch and hold the attention of the students.

Placement. Although there are no official tracks at this school, there is a clear sequence of courses for college bound and another sequence for noncollege bound. Because of a district push to get Hispanic students to reach higher levels of achievement, counselors are trying to encourage more Hispanic youngsters to take more college prep courses and to go to college.

Mastery Math involves individual self-paced instruction from workbooks. Most students work on the basic operations. The later units, that most students do not get to, cover some prealgebra skills.

There has been an increase each year in the number of students enrolled in Mastery Math. Students can be enrolled in this course for two years. When students complete a unit, they take a computerized unit test. They receive 2.5 credits for every 6 units and can complete up to 20 units in

Mastery Math. Most of the other students take Algebra I, geometry, and trigonometry.

The old Math 1A and 1B classes tended to keep low achieving students in a noncollege prep track. The newer Mastery Math course does the same thing. The administrators and some math teachers would like to see a change that would allow the lower achieving students to make the transition to college prep math such as algebra.

The geometry course is currently undergoing some changes in the way it is taught. The new approach incorporates cooperative learning and the use of flexible terminology.

Two years ago, the math department implemented mastery tests. This was brought on by teachers' frustration with the lack of preparedness of students for courses. The mastery tests are used to make sure students can demonstrate the necessary minimum skills to enroll in the next level math course.

In science, there are two kinds of classes--college prep and noncollege prep. All students with reading levels at or above grade level must enroll in the college prep classes. These include Biology, which students take their sophomore year, Chemistry, Physics, Physical Science, Honors Biology, and Microbiology. Students with reading skills below grade level enroll in Life Sciences instead of Biology. For their second course, they can take Exploring Physical Sciences or Earth Science.

Concerns about the effects of tracking have led school administrators to be very concerned about the course-taking patterns of students. For example, although the Mastery Math sequence was designed to be a bridge to Algebra, school data show that most students who enter Mastery Math never enroll in Algebra. The low achieving students, a group in which Hispanics are overrepresented, end up being tracked into a noncollege prep sequence. The administration is encouraging the math department to examine the data and to address this issue. The school invited Jeannie Oakes of The Rand Corp to give a workshop to the teachers on tracking and its effects.

The science department is also looking at the issue of tracking and will probably change the course offerings next year as a result. They are proposing to eliminate the noncollege prep first year science courses and have all students enroll in heterogeneously grouped classes of Biology.

School role. Administrators have not noticed a difference in student achievement or interest in math and science as a result of the new high school graduation requirements. There are no new electives, and they have not noticed changes in SAT/ACT test taking or scores. After-school tutoring by teachers for students who are having difficulty in math is done on an informal basis.

Florida

Traditionally, the Florida State Legislature has played an active role in dictating educational policy and standards, utilizing a top-down approach to achieve policy objectives. However, more recently, the state has shifted toward a more bottom-up approach, emphasizing accountability.

Education in Florida is characterized by a high degree of intervention, but these interventions have not been particularly well-coordinated due to the legislature's tendency to address educational policy one component at a time. Florida utilizes mandates, inducements, and capacity building to influence local curriculum, but the primary policy instrument is mandates. Florida mandates that districts spend half their state allocated textbook money on state-approved books. High school students must earn three credits in both math and science and pass a minimum competency exam in language and mathematics to qualify for a diploma. The state offers monetary incentives for schools that provide 40% lab time in high school science courses. They invest large amounts of money for professional development to promote their educational goals. Capacity building incentives include provision of funds for school site improvement.

Florida has had a strong push to ensure basic skills. This exclusive focus on basic skills is currently being reconsidered in light of recent calls for critical thinking and problem solving. This shift in curriculum focus is illustrated by revisions in the state's testing program. Currently, the state is in the transition process of adding "more higher end questions" to the state test.

Testing. The state test is administered in grades 1, 3, 5, 8, and 10. The focus is on basic skills, with the tenth-grade test comprised of the minimum competencies required for high school graduation. As noted above, consideration is being given to incorporate fewer minimum competency items and more critical thinking items in the state test. Currently the test is only in language arts and math, but state officials would like to see it extended to science.

The State Basic Skills test is used to determine if a school is "deficient." If a school has an average mastery of less than 80 percent in reading, it is considered to be deficient. The incentive to avoid being labelled deficient has brought great interest in curriculum alignment. However, because it is a basic skills test, there is some concern that the policy may result in a curriculum with little or no appeal to eighth and tenth grade students. Some educators believe that basic skills can't be taught to high school students because they get bored, tune out, and end up learning nothing.

State testing program standards are developed by a state-level committee with input from the county/districts in the state. The recommendations of the committee are passed on to the State Board of Education. If approved, the standards become the basis on which state-level tests are developed. The test is changed every year, but the standards are changed less frequently.

Frameworks. State curriculum frameworks are currently under revision by committees of teachers, district supervisors, parents, and administrators. Each framework has three sections: major concepts and concerns; intended outcomes; and student performance standards. The performance standards are intended for use in development of statewide subject area tests. Florida has frameworks for elementary and middle school, but not high school.

Requirements. Three credits of mathematics and three credits of science are required. In addition, 40 percent of a student's time in science class is to be spent in the laboratory. The number of credits needed to graduate is 24 in grades 9-12. There is a sense among educators that the new requirements have not raised the level of material covered, because they do not address how the courses are taught, or how to encourage minorities in math and science. "We analyzed the data and found that they are taking General Math 1, General Math 2, and General Math 3. That's three years of math, but that is not exactly solving the problem," said one state-level administrator.

There are two separate diplomas. The regular diploma requires four years of English, three years of science, three years of math, and three years of social sciences, in keeping with the state guidelines. The academic diploma requires four years of study in each of these four academic areas. The math courses must include Algebra, Geometry, and Trigonometry.

The University of Florida requires three units of math, including Algebra, Geometry, Algebra 2, and three units of science, including two years of lab science as prerequisites for admission (1990-91 academic year). Florida State University requires three units of math, Algebra I and above, and three years of science with at least one year of lab science for admission (1988-89 academic year).

Textbooks. Florida adopts textbooks on a statewide basis, selecting those books that are most closely aligned with the state framework. Districts are required to spend at least 50% of their state textbook allocation on state-approved books.

Professional Development. Since 1984, Florida has invested heavily in math and science teacher training. The legislature recently appropriated $10 million a year for 60-hour summer institutes focusing on content for math and science. The summer institutes are widely utilized by teachers because they satisfy state requirements for continuing education and enable teachers to move up steps on their salary schedule. Most of the teachers we talked to gave high marks to the institutes for being substantive and informative for their focus on content. Teacher participation varies by school and tends to be higher in urban areas where teachers have easy access to local colleges where classes are held. In the two RUC schools in the urban district, it appeared that most of the math and science teachers had participated in the institutes at least once in the previous three years.

Florida - Large Urban District

The district follows the state lead, using mandates and incentives to influence the content of the curriculum. State and district tests are used in evaluation of school and teacher performance. Schools and teachers with high test performance receive monetary compensation.

The district administers two tests annually, one is a state mandated test, and the other initiated at the district level.

In addition to the state basic skills exam, the district periodically administers its own subject area tests to assess the performance of students in individual schools. For example, approximately every third year all Algebra I students may be tested by the district. Students are not held accountable for their performance; in fact teachers complain that they usually receive no information about how their students did. The feedback the district does provide is viewed as minimally helpful because results are aggregated, thus they do not help teachers to diagnose problems of individual students. Despite the fact that district feedback regarding test results is inconsistent, teachers are singled out for scrutiny if their classes perform particularly poorly. District specialists assume teachers are ineffective if their students score low on most parts of the test. In cases where students score poorly on some parts but high on others, the district advises teachers to change their instruction to bring it more into line with district curriculum. We did not learn of any cases in which teachers were penalized in any concrete way as a result of low test scores.

Each year, the district administers the Stanford Achievement Test to students in every grade except grade 12. The test covers reading and writing as well as math applications, math concepts, and math computation. Test results are used to drive an incentive program that gives stipends to teachers who raise their achievement scores above what would be expected from similar kinds of schools and students. The incentive program was not of much interest to teachers and administrators in the schools in the RUC sample. Only a small proportion of schools receive incentives in any given year, and our schools did not consider themselves to have a realistic chance of being among them.

Much of the testing program in the district's schools is determined by the Chapter 1 requirement that students take a norm-referenced test to become eligible for that program. The district administers the ITBS to all students being considered for inclusion in the program.

Guides. The district has lengthy curriculum guides complete with extensive pedagogical suggestions for the elementary level. In high school math and science, however, guides are brief and have little impact on daily practice. The guides consist of the state-adopted outline for a course plus the district's own performance objectives for students. These performance objectives are specific about the behavioral outcomes students are expected to demonstrate after lessons, but the guides say nothing about how teachers are to convey content. A district curriculum specialist said the district makes no effort to enforce strict adherence to guides because the guides are too general to provide clear messages about pedagogy. He also said that strict enforcement of curriculum guides would be incompatible with the district's desire to encourage teachers to utilize new content knowledge they acquire through inservices and to participate in School Based Management initiatives rather than rely on the state and district to define the entire teaching process. The curriculum specialist did qualify his statements, noting that detailed guides are sometimes developed and utilized in new programs such as sex education or AIDS education because teachers often lack specific training in these areas.

In addition, schools are restricted to offering only courses found on the district Curriculum Bulletin. The Bulletin consists of all the courses on the list of state-approved courses, plus a small number of experimental courses adopted by the district and approved by the state on a course-by-course basis.

Textbooks. The state requires all districts to use 50 percent of their state textbook money to buy textbooks that appear on the state-approved list, leaving some flexibility in the choice of textbooks. However, the large size of this district means that it has considerable say in what textbooks the state will adopt. Almost all of the textbooks the district recommends to the state are subsequently adopted. As a result, there is a large overlap between the district and state level text guidelines. Not surprisingly then, this district requires that 75 percent of textbook funds must be spent on State-approved textbooks.

Professional Development. The state provides the major source of inservice funds for a summer institute in content-oriented training in math and science. In 1990-91 the state spent $9 million on the program, plus another $2 million on a program to retrain elementary teachers in math and science. Teachers from F1 and F2 utilize these programs regularly. In addition, Title II provides some funds for university tuition and books and a small cash incentive for completing course work.

Evaluation. The principal or vice principal reviews all lesson plans and conducts all formal observations according to a standard district instrument. Lesson objectives must be based on the district curriculum. Following the evaluation, the principal or vice principal meets with the department head to discuss the evaluation. Written recommendations are prepared and delivered to the teacher. Teachers who are deemed deficient in some area are scheduled for a series of three more observations, two of which must result in positive evaluations to remove the teacher from further scrutiny. In this district, evaluation of teacher performance also is based on student test scores. The district uses statistical techniques to predict the standardized achievement test scores expected for students given their socioeconomic status and their previous test score. The district evaluates teacher performance according to the variance between actual and expected performance. Teachers receive $1,000 to $2,000 stipends if their classes post unusually large gains on the Stanford Achievement Test compared to similar classes in the district.

As noted above, the district has also developed a battery of subject area tests to assess the effectiveness of schools and teachers. These tests are developed from an item bank designed by the district to reflect district performance objectives as specified in district curriculum guides. Eventually, district testing specialists hope to have over 1000 items per subject from which to construct the exams. Currently the bank has approximately 600-700 items for each subject.

One district curriculum specialist predicted district testing may one day have substantial impact on classroom practice because teachers have free access to the item bank and can therefore readily orient instruction to the items. However, at this point, because subjects are only tested every third or fourth year, testing is too infrequent to stimulate constant teacher attention to test content.

Student Characteristics. In this district, scores on basic skills tests have been going down. The community has been getting poorer, but district officials could not say whether this influence is strong enough to account for the total decline in test scores. The district has also grown rapidly. Many of the new students are immigrants or migrants, and thus schools must provide extensive ESL programs. However, because many schools cannot find enough qualified bilingual teachers, most LEP students take some classes with teachers who speak only English. This has affected F1 very much due to the large number of Hispanic students, but this is less of a problem at F2 where virtually all students are African American.

Florida: Large Urban School (F1)

Requirements. When the state of Florida increased the math requirement for high school graduation to three credits, F1 adopted a new policy requiring all students to take four years of math. Although this increased the average number of mathematics credits taken per student, it did not necessarily have a dramatic impact on math achievement in the school. Many seniors choose to take courses such as Business Math or Consumer Math that contain little new content instead of going on to courses such as Trigonometry or Calculus.

Textbooks. State and district mandates that textbooks be selected largely from the state-approved list mean that there is very little flexibility in textbook selection. Some teachers and departments at F1 have greater success than others in getting permission from the assistant principal for curriculum to buy texts not on the state list. Others concluded that the texts on the list included the ones they would have been most likely to choose anyway. Furthermore, teachers felt free to use or ignore texts as they saw fit. Several teachers reported finding relief from district policy by continuing to teach out of old texts even after receiving new ones.

It appeared that administrators almost never invested their time and organizational resources in pursuing extensive evaluation and supervision of teachers whom they considered to be incompetent. For example, upon informing F1's assistant principal that a particular math teacher was among those we intended to seek out as target teachers for RUC, the administrator told us quite plainly that we should omit the teacher from the study. He said the teacher is totally ineffective and that the individual would never supply us with the data we required. We subsequently learned it was public knowledge that this teacher's classes were mayhem. When we visited the teacher's classroom--a room shared with another math teacher who did work with us on RUC--we found it reeking of smoke. There was a large scorched hole in the ceiling tiles where, we were told, students had thrown books through the ceiling and started it on fire during class the previous day. Despite the administration's knowledge of the teacher's incapacity in the classroom, no steps were taken toward removal. On one occasion the assistant principal did express appreciation for the fact that this teacher was nearing retirement.

Resources. Resources are divided according to priorities established by the school administration, with textbooks taking first priority. F1 had a greater number of computers than many of the schools we visited. The remedial math class we studied had a dozen computers equipped with a special program for drill and practice in basic skills. The science department lacked adequate lab space and equipment. Due to overcrowding in the school, teachers often had to change rooms between classes. Changing rooms had particular impact on science teachers who could not possibly carry the equipment required for certain types of labs or demonstrations from room to room. Also, since some of the classrooms used for science classes were portable units with no plumbing, wet labs were not always possible.

Students. F1 had just over 3000 students in 1989-90. About 41% are Hispanic, 38% are African-American, and most of the remainder are Caucasian. The counselor described the socio-economic status of the student population as ranging from poor to middle class, with the bulk of students being lower-middle income. Standardized test score averages for F1 are essentially at the district median. However, African-American students at F1 score between five and ten percentiles above the median for their group, Hispanic students score at about the district average for their group, and white students generally score below the district average for their group. One factor that may help explain the comparatively high achievement of ethnic minorities at F1 is that the Hispanic and African-American students at F1 were from higher income families than their counterparts at many other schools. Furthermore, the white students at F1 were, on average, less well-to-do than white students elsewhere in the district. It is possible that the school was also more effective at delivering certain kinds of instruction, but the minority student population at F1 may have been better positioned to take advantage of the school's efforts than their counterparts at schools such as F2 where black students are impoverished and score poorly on standardized tests.

Placement. At F1 counselors utilize students' grades, test scores on the Stanford Achievement Test (previous to this the California Test of Basic Skills was used), and teachers' recommendations, as well as their own judgements about student ability to decide which classes students should take. The district also grants parents final authority, thus some students enroll in courses that teachers or counselors consider inappropriate for them. The students are tracked into college-bound, regular (or general), and vocational programs. The college-bound track is college preparatory; the regular program prepares students for the world of work, armed services, or college; while the vocational track limits the student to the world of work and the armed services. The math department chair felt this system was unfair to the vocational track students.

Students are placed in science courses based on their Stanford Achievement Test scores. Entering freshmen who score in stanines 1-3 are placed in Fundamentals of Physical Science. Those who score in stanines 4-6 are placed in Regular Physical Science, and students in stanines 7-9 are placed in the Honors track.

Students are advised by the counselor about high school graduation requirements and college admissions requirements. Students also receive a computer printout showing which courses students should take given particular career aspirations.

The math curriculum includes General Math, Prealgebra, Algebra I, Algebra II, Geometry, Informal Geometry, Trigonometry, Calculus, and AP Calculus. The science curriculum pattern for the "regular" track is Physical Science in the 9th grade, Biology in the 10th, Chemistry in the 11th, and Physics in the 12th. Few students take four years of science; those who do tend to choose Marine Biology or Anatomy and Physiology over Physics.

Florida - Large Urban School (F2)

This school takes a top-down strategy to implementing state and district policy, with the department chairs holding considerable administrative responsibility. The department chair and the department work out course offerings and teacher assignments for that department, in conjunction with an administrative team that tells them how many of each class is needed. The department looks at the needs and the strengths of the teachers and then develops course offerings and a master schedule. Weekly lesson plans are developed and kept by the department chair.

Graduation Requirements. When the state requirement moved from 5 credits per year to 6, the school increased from a six- to a seven-period day. One reason the district switched to a seven-period day was to allow students to satisfy the new higher requirements in core curricular areas such as math, science, social studies, and English without reducing coursetaking in areas such as vocational education, music, and art. It does not appear that vocational coursetaking at F2 was bolstered by the seven-period day, but vocational courses at F2 have never attracted many students. The move to the seven-period day did not have a dramatic effect on course offerings in any area, including math and science. In some instances, new courses appeared on the list of course offerings; however these were often courses that covered the same content as had been offered under some other course title. The biggest change we noted was in remedial math: all schools began teaching courses specifically tailored to the then new state basic skills high school exit exam.

The math department chair expressed mixed feelings about the new state requirements in mathematics. On the one hand, he noted, it is good to have students take three years of math. Students remember it better when they leave, and colleges and employers are happy because the students can do math. On the other hand, it has put a greater burden on the students and more pressure to not make any mistakes; with the number of credits needed to graduate, there is very little leeway for mistakes.

The school experienced a severe shortage of teachers and materials on the implementation of the new math and science requirements. The teacher shortage was addressed in part by paying teachers an additional 1/6 salary to teach an additional period of science. The district also replaced its junior high schools with middle schools and transferred the ninth grade to the high school. Both staff size and the size of the student population increased at the high school level, and thus organizational resources directed to secondary schools were expanded. Also high schools had greater control of ninth-grade course offerings and student placement than they had had under the junior high format. Despite these changes, there is still a shortage of well-trained teachers in beleaguered schools such as F2.

The science department chair reported that the state requirement that 40 percent of science class time be spent in labs has been very difficult to implement. Difficulties were attributed to the shortage of lab facilities and equipment and supplies. However, it is not clear that teachers could spend this much time in labs even if they had all the equipment and supplies they needed unless they also had more preparation time for classes. Luckily for most science departments, schools self-report on time spent in labs; any school that does the paperwork required by the state receives the funds.

When the new requirements were enacted, there was a concern that the increases would lead to an increase in the dropout rate. However, a dropout prevention program that starts in the middle schools has helped address this problem. The negligible impact of requirements on the dropout rate is also partly explained by the fact that students may satisfy the new requirements by taking insubstantial courses; for example a student may obtain the necessary math credits by taking General Math I, Basic Skills Math I, and Basic Skills Math II. Few students who desire to pass these courses are unable to do so, irrespective of previous math achievement.

Textbooks. At F2, the teacher and the department chair select a textbook from the state-approved list. The school requires that textbook selections be uniform for each subject in order to facilitate the movement of students from class to class.

Professional Development. The school has a Peer Teacher program that matches new teachers with more experienced teachers who evaluate their lesson plans, in addition to state and district initiatives on staff development.

Teacher Evaluation. First-year teachers are observed four times a year, twice by the principal and twice by a designee. Second- and third-year teachers are observed twice during the year, and a professional contract teacher who is satisfactory is observed once during the year.

For every negative observation, a prescription is developed by the teacher and the observer with a date to achieve that prescription. An observation will occur on that date. For a teacher who gets one negative observation, two positive recommendations are needed. A teacher who is deficient in an area and is under prescription can take a set of courses designed to improve performance. Technically speaking, a teacher may be dismissed for not eliminating major deficiencies after extensive assistance from administrators. We did not hear of any case in which a teacher in either of the Florida urban schools in the RUC sample had been dismissed, despite the fact that some were themselves clearly struggling with the material they taught or entirely lacking control over students.

Resources. For the most part, department heads are responsible for the inventories of educational supplies. Teachers submit requests for materials to the department chair. In addition, audiovisual materials are available on the school site. An infusion of state dollars ($25 million was allocated in 1990-91), earmarked for upgrading science facilities, went primarily to particular schools for building new labs. F2 received no money for this purpose, perhaps because the district was considering replacing the entire physical plant with a new building. A substantial portion of state funds allocated for science also went to schools that spent 40% or more of science class time in labs. All the schools in the RUC Florida sample received money under this program, primarily because they adopted a very liberal definition of what constituted a lab in the self-reports on which funding was based.

Students. F2 is one of the most racially homogeneous schools we encountered. Virtually all of F2's students are Africa-American and reside in the impoverished inner-city neighborhood surrounding the school. In 1988-89, the school enrolled about 2100 students (575 in grade 9; 640 in grade 10; 620 in grade 11; and 275 in grade 12). These numbers reflect the high dropout rate:

according to the head counselor, over 40% of the students who begin at F2 leave high school before obtaining a diploma. Students at F2 score substantially below the district average for black students on all areas of the Stanford Achievement Test, and farther yet below the median for white students.

Placement. Student grades, test scores, and teacher recommendations are used to place students in math and science tracks. Ninth-grade students are placed based on the recommendation of eighth-grade teachers, along with the students academic records. Parents can argue for a change in the placement, and the school generally tries to honor such requests.

Students are typically placed in one of three tracks: remedial, regular, or CP/Honors. F2's head counselor estimated that 30% of F2's students were in the remedial track, 60% were in the regular track, and 10% were in Honors courses. The remedial math sequence consists of General Math I, General Math II and General Math III. Students who fail the state basic skills exam are pulled from General Math and enrolled in Basic Skills Math until they succeed on the test. Students in the regular math sequence usually begin with Algebra I, then take Informal or regular Geometry, and finish with Consumer or Business Math. Some regular track students begin with Prealgebra, then proceed to Algebra I and one of the other courses. Honors students take special sections of Algebra I, Geometry, and Algebra II.

The lower track science sequence is Fundamentals of Physical Science, followed by Fundamentals of Biology, and Fundamentals of Earth and Space Science. Regular track students take General Physical Science in grade 9, General Biology in grade 10, and one more course in grade 11. Chemistry is the course chosen by juniors who wish to qualify for a state program that awards college grants to students who complete a specified high school course of studies; other juniors typically turn to Marine Biology, Ecology, or Anatomy and Physiology for their third science credit. Honors students take special sections of Physical Science, Biology, and Chemistry; many Honors students also take Physics.

There are some opportunities for changing tracks. For example, the Prealgebra class has been restructured so that it can provide a bridge for students who did well in the General Math sequence to enable them to take Algebra 1.

Student placement for some ninth-grade students underwent a major change for the 1988-89 school year when the school began experimenting with a new program. The program, referred to as "The Center" by staff, was designed to transform the school from one that offered traditional courses of dubious academic quality to one with a rigorous, academic core curriculum for all students. The initial plan called for a one-year pilot period involving about 25% of the ninth graders. Year two of the plan called for extending the program to the entire ninth grade. From that point the program was to move through the school with the ninth-grade cohort, eventually leading to the entire school operating under the new curricular model.

The school received an estimated $1 million from a private foundation committed to the venture. This money was used to develop new curricula, buy equipment, and hire all new staff to implement the program. Staff were given extensive support and their own administrator--a man who was highly committed to the program's success.

Despite the high level of resources committed to The Center, the initiative faltered after the first year. The Center became highly divisive because teachers who had worked at the school previous to the initiative concluded that their having been excluded from participating in the piloting of the program meant they would ultimately be pushed out of the school entirely rather than be incorporated into the new effort. The conflict over the new initiative was quickly publicized in local papers. In 1989-90, the district backed off from its plan to expand the program to the entire ninth grade. In the meanwhile, about a quarter of the school's ninth graders continued to be channeled into the experimental program with a common academic core curriculum.

Florida - Smaller Rural District

The rural Florida district in the RUC sample is one of the most impoverished counties in the entire state. The local economy depends heavily, both directly and indirectly, on federal dollars, but the federal funds are insufficient to overcome chronic unemployment. The public schools in the district have much competition from private and parochial schools. Most families that can afford the tuition send their children to private schools; including the white men who sit on school board for the public schools. The student population in district public schools is officially described as 16% white and 84% black. These figures, however, do not account for the substantial number of children from migrant Hispanic families who attend county schools at certain times of the year. Integration has not come to the district as readily as desegregation. Some white students now go to classes with black students, but at F3 the two groups continue to hold separate proms and generally avoid one another away from school.

The district has demonstrated little capacity for innovation in math and science curriculum and provides little support for math and science instruction or professional development. Aside from accommodating state mandates, the district has done little to influence classroom practice among teachers. One exception was evident in 1988 when the district experimented with creating its own criterion-referenced testing program as part of an effort to hold teachers and students accountable for basic skills content. The testing program, purchased from a private consultant, was based on a data bank consisting of 88,000 items in 40 different subject areas. The theory behind the data bank was that the district could build its own tests for each subject covered in the county curriculum by combing through the bank for appropriate items. Upon constructing these tests the county declared that all students who failed to master them at a prescribed level would be denied course credit and, where appropriate, grade level promotion. Course failure and grade retention rates skyrocketed the first year the tests were given (500 students were retained on the basis of poor test scores). The district promptly abandoned the program and has subsequently relied on state programs to specify necessary basic skills content and assessment methods.

Testing. The district administers the state basic skills exam and the CTBS, a national norm-referenced test that includes sections on math computation, math concepts, and applications.

Guides. District objectives are developed in line with the state objectives. The district curriculum specifies "performance standards" to which instruction is to be geared. Performance standards are stated as student behavioral objectives. Pedagogy and assessment are not specified by the district guides and are presumably addressed by the textbooks prescribed for each course. Many teachers consider the district curriculum guides to be obsolete and poorly aligned to current textbooks and professional standards.

Requirements. In addition to the new state requirements, there is a 1.5 minimum GPA for graduation in this district. There is some sentiment that changes in state graduation requirements have made a difference for high achieving students. There have been increases in the enrollments of honors and Advanced Placement classes in both mathematic and science, and Achievement Test Scores and Advanced Placement scores have been improving. "When you require more mathematics from a student who is average or bright, then they will take classes where they will learn something." On the other hand, there is agreement that there has been little difference for the lower achieving students. A district administrator explained, "When you require more mathematics from a student who has not learned basic skills by the time they're in the 10th grade and do not change the content that is delivered, they do not learn more mathematics."

Textbooks. Working from the list of state adopted texts, the district narrows the options to 2 or 3 books per course. Each school then chooses the district approved texts they will use for each subject. Teachers serve on the district committees for textbook approval.

Students. District enrollment has remained stable since 1987-88 when it was approximately

8300 students (3400 in grades 7-12). As noted above, 86% of the students are African-American and the remainder are white. During certain seasons, children of Hispanic migrant families also attend district schools. In this school district, test scores went up considerably from 1977 to 1984. This improvement enabled the district to keep up with increases elsewhere in the state, but the district did start out at a much lower level. For example, 9th graders in the district were in the 29th percentile nationally for the entire CTBS battery in 1987-88.

Black students are disproportionately affected in district disciplinary actions. In 1987-88, no white students were expelled, and only 69 were suspended, whereas 16 black students were expelled and 983 were suspended.

Tracking. The district computer does all the placements of students. School administrators and faculty do not have the flexibility to place students according to individual needs. In addition to placing students in general or college prep courses, the district relies heavily on vocational courses to fill out students' programs. Students in the vocational track leave their regular school each afternoon to take courses at a centralized county vocational facility. Parents sometimes override the district's choices and insist on enrolling their child in a course of their own choosing.

Restructuring. There is a great deal of frustration that the reforms enacted at the state level have not made an impact. One district official said, "I don't know if it's the geographical location, but it shocks me that I am sitting [very near] the state capitol and we are not doing anything here in the realm of effective teaching, effective schools--nothing."

Florida - Smaller Rural School (F3)

There is a striking sense of frustration among school personnel regarding the inability of the school to implement state reforms. The biggest barrier to effective implementation of policies and programs is racial segregation of both students and staff at the school and the general poverty conditions in the surrounding community. Black and white teachers seem not to want to socialize with one another. The principal is trying to work out a resolution to this problem, which he attributes to lingering tension over the fact that the institution of slavery was once very prominent in the area.

Interviews with teachers, staff, and administrators invariably return to the issue of ethnicity and the frustration that no one in the state, county, or district seems to care about what is happening there. There is a sense that school administrators feel the problems they face are too large to tackle themselves, a general sense of helplessness.

Guides. A major change at this school has been in the development of district objectives. Teachers refer to district curriculum objectives as guidelines in the development of courses, but the objectives have limited impact because they are not particularly well aligned with textbooks or the advice of professional organizations such as NCTM and NSTA.

Requirements. Despite changes in the state graduation requirements, there has been little effect on nationally standardized test scores in math and science.

Evaluation. Teacher evaluation is sporadic and uneven. Lesson plans are required but not collected. The principal estimates that only 15 percent of the teachers have lesson plans. The teachers' yearly evaluations are based on a one-period observation by the principal. This year, in addition, the assistant principals conducted short random observations that were to have been incorporated into the evaluation. However, the observation write-ups were never formally completed.

Resources. At F3, resources are very scarce. Funds are distributed in a lump sum to departments; departments vary in the degree to which they are centralized. The science department at F3 orders as a department; because spending occurs on a smaller scale, it is more difficult to ascertain control of spending in the math department. The school has very few computers. Due to a scarcity of lab facilities and supplies, the RUC target teacher for Biology at F3 reported that he rarely conducted legitimate labs.

In F3, there is a shortage of qualified science teachers. The district has had to encourage teachers with biology certification to gain certification in physics.

Students. Most students come from poor rural homes in a county that is predominantly poor and black. There is substantial segregation among black and white students. For example, black students hold and attend the black prom, while white students hold and attend a "spring frolic."

The dropout rate is high at F3, and test scores are low. On the state math assessment test, F3 scored in the 67th percentile. On the ACT, the average score is 14 of a possible 36, with the scores of black students ranging from 2 to 9. Students who do not pass the test required for graduation must take a year-long remedial course, which they will take until they pass the test. About 30 percent of the students at F3 who take the remedial course never get out of it.

Placement. At F3, there is only one counselor for the entire school, so about all that can be done is to ensure that the student has the required courses for graduation. The counselor provides students with general advise about which diploma to go for by talking to entire classes at once and encouraging the college bound student to strive for an academic diploma. The counselor only sees about 55 percent of students on an individual basis.

The school counselor reported that teacher expectations of students in the regular diploma track are lower than their expectations of students in the academic diploma program. Teachers see the regular students as slow and tend to feel that those in the regular track are not going to do anything but work in menial jobs in nearby federal institutions or end up on welfare.

Students pursuing an academic diploma start in Algebra I, while the other students generally take General Math I their first year and then choose two of General Math II, Consumer Math, and Business Math.

The math department chair reported that there are not enough students to offer courses in the higher levels of mathematics, or AP courses. The science curriculum is fairly limited and includes only Physical Science, Biology, Chemistry, and Physics.

Promising Practices. The school is currently considering a proposal to test students in Black English rather than standard English, but nothing has come of this idea so far.

Another program exists that allows high school students to attend the local community college. In doing so students can get high school credit while taking rigorous courses that better prepare them for college. Some students are reluctant to take their coursework at the community college because it is generally believed that the college teachers grade more stringently. Grades concern some students who want to maintain a high grade point average to gain admission to selective colleges. Students who take coursework at the community college tend to score higher on the ACT than students who remain in classes at the high school.

Despite the generally poor state of education in this rural Florida school and its district, we saw several teachers providing high quality instruction as a result of their own dedication to their students and their own work. It was our impression that most teachers in the school were isolated from one another, and these teachers were no exception. Thus, there was no mechanism for building on promising practices already existing in some classrooms.

Missouri

Missouri is a low intervention state with a tradition of local autonomy. The state provides some technical assistance to school districts and some leadership in curricular matters. Missouri has a state achievement test (MMAT) and has recently adopted a set of core competencies. While the test does to some extent shape district curriculum guides, state policymakers felt that the overall influence of the state on local practice was minimal. For example, although the state required districts to make test results available to the public according to freedom of information laws, it does not require districts to report MMAT scores to the state education agency. The state's poor financial condition has further weakened the state's influence upon local practice.

The state curriculum specialist for science is working to change curricular philosophy from "discipline-base layer cake math and science . . . to overall science." To promote the goal of integrated science, a committee was appointed that created three broad categories of scientific concepts: life and living things, matter and energy, and the earth and the universe.

Missouri's science curriculum specialist felt that the biggest impact of state core competencies and the state MMAT is that they "generated a substantial amount of science in elementary schools." This individual also felt that the state policies had not had a substantial impact on high school math and science teachers. "No, not big changes. I think that still high school science is basically a lecture, textbook, discipline based course, sprinkled with activities that pass for laboratory investigations that are generally laboratory reconfirmation of the obvious."

One state administrator stated that the NCTM *Standards* were totally compatible with Missouri's math objectives. However, although the standards may be compatible with his vision of what should evolve in Missouri, their use was not widespread.

Testing. Since 1985, the State Department of Education's mission has been to change the policy focus from teacher concerns to student learning. After the competencies and key skills were developed in 1985, the MMAT was constructed to encourage "mastery of at least those key skills that are amenable to paper and pencil testing." The MMAT is a criterion-referenced test that covers reading, mathematics, science, and social studies and is closely correlated with the core competencies and key skills specified for each area. The state requires districts to administer the test a minimum of four times between grades 2 and 10. The state does not have the authority to impose sanctions for poor performance and can not afford to provide incentives to schools. However, school level interviews indicate that some school administrators (especially those in exceptionally low achieving schools such as the two urban RUC schools) consider good test scores critical and pressure teachers to cover state objectives.

The MMAT was phased in over a two-year period. Tests in grades 3, 6, 8, and 10 were available for the first time in 1987. In 1988 the test was available at all levels in grades 2-10.

MMAT test scores rose initially but have recently leveled off. Each subtest in the MMAT battery was originally calibrated to a statewide median of 300 at the time of the first administration of the exam. The state average scaled score for students in grades 2-10 rose 20.4 points from the first to second administration of the test battery. For 1989 and 1990, the two most recent years for which tests scores were available, the average scaled score rose less than one-half point statewide for the entire test battery. In mathematics, the average student answered 59% of the items correctly in 1987 and 70% in 1990. In science the average percentage correct rose from 48% in 1987 to 58% in 1990.

Frameworks. In 1985, teachers and state curriculum specialists collaborated to develop a highly specific set of core competencies (behavioral objectives) and key skills (learner outcomes). The effort yielded separate booklets of core competencies for each area tested on the MMAT in grades 4-10. The booklets specify core competencies to the letter and are thus lengthy documents. The state book of core competencies for mathematics for grades 7-10 is 99 pages; the science booklet is 243 pages.

The core competencies are not intended to be course specific but are readily accommodated within traditional courses. For example, core competencies in mathematics for 9th and 10th graders include significant amounts of basic algebra and geometry.

Requirements. The state of Missouri requires two years of science and two years of math for high school graduation, an increase of one year for each subject compared to the pre-1988 requirements. University requirements differ across state campuses. In 1988-89, Missouri Southern State required three years of math and three units of science. The university further required that one year must be in Algebra and the other two years above the Algebra I level. General Science did not count for the science requirement. In 1989-91, the University of Missouri at Kansas City required three units of math (Algebra I and higher) and two units of science, including one year of lab science. In 1990, Southeast Missouri State required two units of math and two years of science. The two math years must be Algebra I and higher.

Textbooks. The state does not play a role in textbook adoption; districts adopt textbooks in Missouri. State officials emphasized that local textbook adoption reflects the high degree of local autonomy that permeates all aspects of Missouri educational policy.

Professional Development. In Missouri, the ratio of teachers to state curriculum specialists is 30,000 to 1; financial constraints limit the state's ability to provide staff development. Officials have tentative plans to establish 10-12 inservice training centers throughout the state to provide content and background knowledge to teachers. State specialists envision providing support to selected teachers who will in turn do the actual work of conducting inservices.

Eisenhower money is also used in the state to provide math and science teachers with opportunities for continuing education and graduate course work. Unlike other states, the state education agency in Missouri does not control all or even the majority of Eisenhower funds. Most DEMSEA money is controlled by the Coordinating Board for Higher Education. The state science curriculum specialist said his office works closely with the Coordinating Board and estimated that as many as 25 to 33 percent of all teachers may participate in a DEMSEA funded course or workshop in a given year. However, as noted elsewhere, the state does not have a large regulatory presence and thus does not have specific data on teacher participation in professional development activities

Missouri - Large Urban District

The district does not adopt the state's hands-off approach but uses mandates and professional leadership to influence math and science curriculum. Teachers have relatively little formal input, because district and school administrators retain decision making power for themselves.

Testing. The district administers two tests at the high school level: the state MMAT and the district required Test of Academic Proficiency (TAP). The district administers the state MMAT test once to high school students in the tenth grade and is one of the few districts that administers the state test the minimum of four times between grades 2 and 10 (Most districts administer the MMAT every year between grades 2 and 10.). The district testing coordinator characterized the MMAT as a "strictly lower end" test, although he indicated that the state would dispute a characterization of the test as a minimum competency test.

Scores on the MMAT have risen in the district since the test was first introduced, although gains were small in 1988 and 1989. Although students in the district had been bringing up their scores, the disparity between the district and state average was growing as a result of yet greater increases in test scores statewide.

The TAP administered by the district is a multiple-choice achievement test that emphasizes memorization of facts. The district has used Form T of the TAP since 1978. This version of the test covers reading comprehension, mathematics, written expression, using sources of information, social studies, and science. It is administered each year in grades 3-12. In most subjects and grade levels, the district evidenced no gains relative to national norms for the years 1985-89 but posted modest gains in certain subjects at some grade levels.

The only dramatic gain for grades 9-12 was made in 9th-grade science where students went from the 18th to the 31st percentile between 1985 and 1989. Most of the improvement came between 1988 and 1989 as the median score for ninth graders in science went from the 22nd percentile to the 31st percentile. This gain is probably explained by a district decision to change the order in which students take physical science and biology. Prior to the change, most freshmen were placed in courses such as Introduction to Biology, Biology I, and General Science. Yet, the ninth-grade science subtest for TAP places heavy emphasis on physical science. Realizing this, when the district decided to intensify efforts to produce higher test scores, it reorganized course sequences making physical science required for all ninth graders.

In all other subjects and grade levels gains ranged from 0 to 4 percentile points. The district failed to reach the national norm in any subject at the secondary level. In math, in 1989, the students in grades 9, 10, 11, and 12 scored in the 28th, 34th, 35th, and 37th percentiles respectively. The percentiles for science, again in grade order, were 31, 26, 26, and 23.

Raising test scores was clearly a high priority for every administrator we interviewed. The district math specialist reported that the district placed heavy emphasis on aligning curriculum with the MMAT and TAP tests and further explained, ". . . the teachers here are strictly accountable and the superintendent has as one of his goals to get these different schools at different grade levels within the school at national norms if at all possible. So they [teachers] have to be totally aware of what is tested and what is not and what will be utilized for [student] evaluation."

According to the district testing specialist it was not only students who were evaluated according to test scores; the school board used scores explicitly to evaluate the superintendent, his staff, and building principals. Administrators were told they would lose their jobs due to school board impatience over test scores, and in fact some eventually did.

Additional pressure to raise test scores was being put on the district by a federal judge who had issued and was monitoring a desegregation order in the district. A key feature of the desegregation plan involved dramatic increases in local district and state fiscal support for district schools. The judge was committed to ordering increased tax levies in the state, but only so long as the district could demonstrate, among other things, that increased revenues were producing higher achievement as measured by standardized achievement tests. With approximately $385 million dollars at stake, concern over standardized test scores had reached a fever pitch with virtually all district personnel during the time of our study.

Not only did the involvement of the federal courts increase the salience of test scores in the district, it also influenced the nature of the testing program. According to the district testing director, there was a consensus among upper-tier district administrators that the relative emphasis placed on the TAP and MMAT should be reversed. It was their thinking that the district would be better served by regular use of a criterion-referenced exam and only occasional administration of a norm-referenced test. The federal court, however, constrained the district from making such a change because the MMAT had been only recently introduced. The court wanted to compare student achievement under the desegregation order to performance in preceding years when only the TAP (or, at the elementary level, ITBS) was administered to all grades. The district felt locked into yearly administration of the TAP at least until 1992 when the court order was expected to expire.

Guides. The district produces math and science curriculum guides that align the content for district courses with the MMAT and TAP tests. The district guide used for mathematics at the time of our field work was about to be replaced with one that was described as being similar in form and function. The old guide was approximately 400 pages in length. It included course descriptions, behavioral objectives, end of grading period tests, and tables indicating on which pages in the approved textbook teachers could find lessons pertaining to each objective. The tables also indicated whether the objectives are aligned with the MMAT or TAP test. The old guides also indicated how objectives were aligned with a state minimum competency high school exit exam that was no longer in use at the time of our study.

The old guide devoted 72 pages to a set of courses including Fundamentals of Math years I, II, III, and IV; 57 pages to General Math and Practical Math; 36 pages to Basic Algebra and Algebra; 38 to Basic Geometry and Geometry; 82 pages to Advanced Algebra, Trigonometry, Pre-calculus, and Calculus; and 62 pages to three courses in computer programming. The section devoted to General Math and Practical Math had the greatest number of student behavioral objectives, with 332. The section for Basic Algebra and Algebra listed only 111 learning objectives, the fewest for any section.

The new guide was expected to look very much like the old one, but it was expected to play a new role in textbook selection. The new guides were being completed just prior to a new textbook adoption cycle and could be used as a basis for textbook selection.

Linking textbook selection to the guides in this way had the potential to effect substantive changes in curricula. The district curriculum specialist for math told us that many of the objectives in the new math guide were inspired by the NCTM *Standards* and were not directly assessed by either the MMAT or the TAP. If this was true, then the new district guides provided a concrete mechanism for incorporating the NCTM *Standards* into the formal curriculum, and the likelihood that the new curricula would ultimately be enacted by teachers was enhanced by the prospect that the textbooks supplied to teachers were going to be more reflective of that curricula.

Since we did not have access to the new guides, it was impossible to assess the extent to which they moved toward NCTM-like content. Moving toward NCTM could easily have contradicted the district's well-established emphasis on basic skills. Serious conflicts between competing goals might have been avoided if the guides made only superficial attempts to incorporate NCTM-like content or if problem-solving and application were incorporated only into upper level courses to have minimal impact on math instruction as a whole. Again, data were not yet available to assess whether new curriculum guides were going to modify the district's emphasis on basic skills.

Science curricula were undergoing similar changes. Probably due to the greater length of science curriculum guides, the science specialists were not as far along in the production process as the math specialists at the time of our study.

A district curriculum specialist summarized the ultimate goal to be reflected in the new guides, saying, "We want a good solid course that includes those [state] competencies that are tested but also includes all other competencies we think a student needs to graduate from high school." Teacher and administrator responses to the usefulness of existing guides varied widely and will be discussed below where we address curricular policy and practice in each school.

Requirements. The district requires three years of science and three years of math for high school graduation, one more year than the state in each subject. As of 1990-91, the district science requirement included a stipulation that a student must take a minimum of one life science and one physical science course. Previously, three years of any type of science fulfilled the requirement. The specification of particular types of science courses is explained by district attempts to channel students into courses where they will be exposed to content covered on the MMAT and TAP exams.

Text Adoption. The district has a textbook committee that consists of teachers nominated by principals. The committee relies on district curriculum specialists for logistical purposes, but the teachers alone vote on which text will be adopted. Teachers do not receive additional compensation for serving on the committee. Textbooks are on a seven-year adoption cycle. One text is chosen for each district-approved course, and all teachers are required to use the district-adopted text.

Professional Development. Inservices are typically held on the school site during the summer. The district uses its own operating funds to schedule graduate level courses to enhance the math teachers' skills. Only about 5-10% of the teachers participate on a first come, first serve basis. The district also supports science workshops periodically on Saturdays, which are voluntary and well attended. Attendance at these workshops may be boosted by the small stipends paid to teachers who attend.

Teachers also have access to Eisenhower funded workshops and inservice through the state department of education and state colleges and universities. District level data on teacher participation in these inservices was not available. The district did, however, expect increased involvement in continuing education because the state had recently done away with lifetime teacher certification.

In the past, the district brought in outside people for staff development, but the teachers prefer to teach one another. For this reason the schools we studied were relying primarily on their own staff for leadership in professional development. Most of the workshops conducted in the two schools studied by RUC were oriented to pedagogy and classroom management, not content. Teachers attributed little importance to these workshops and reported they did not influence course content.

Evaluation. Revised in 1983, the district evaluation rates teachers on eight dimensions, including clarity of objectives, appropriateness of objectives, progress toward accomplishing objectives, and several measures of classroom management and pedagogy. Nontenured teachers found to be performing below standard may not have their contracts renewed for the following year unless they remedy the deficiencies and perform adequately in a follow-up evaluation. Probationary teachers (fewer than 7 years in the district) are observed annually; tenured teachers (7 or more years in the district) are observed in alternating years.

Resources. The district was using desegregation funds to convert every school to a magnet format over a three-year period. The plan, as noted previously, brought over one-third of a billion dollars into the district. The money was used to make major renovations in the physical plant of virtually every high school in the district. One high school experienced an $8 million cost overrun on renovations. Schools were to receive expensive, state-of-the-art equipment to support instructional programs targeting highly technical professions. Teacher salaries were raised as class size was reduced. Resource specialists were hired to help schools articulate and implement curricula based on their magnet themes. Each school received an additional administrative position. Millions per year were spent on an expanded transportation system to shuttle students from every neighborhood to all parts of the city. In 1990, almost $1 million was paid out in cab fares alone for the purpose of transporting white students from the suburbs to inner-city magnet schools.

Each school also received $300,000 annually in school improvement funds on top of traditional general operating funds. Principals established committees to set priorities for spending this money. The committees had few constraints except that the money could not be used to augment salaries of existing teachers and was to be used to support instruction and higher achievement. In 1989-90, for example, school M1 used $50,000 to hire a reading specialist and buy additional computers for the school reading lab; $7,000 was spent on increased photocopying to enable teachers to duplicate practice exercises for MMAT and TAP tests; $2,500 was spent to fund extracurricular academic activities; $24,000 was spent to hire a supervisor for the in-school suspension program; and $20,000 was used to fund workshops and hire substitutes for teachers attending workshops. There were many other expenditures, most ranging between $1000 and $4000 in cost. M2 spent school improvement funds in a similar way. Principals also tended to give each department in the school a lump sum to spend on supplies and equipment as they deemed appropriate. Later we discuss how the math and science departments at M1 and M2 spent this money.

Another big budget line for the district was the addition of one administrative position to every high school in the district. The superintendent created the position to ensure that one person in each building was coordinating implementation of district curriculum policy. First and foremost this meant aligning curriculum, pedagogy and student and teacher evaluation with testing. The superintendent's belief was that this strategy would raise student test scores.

Students. The development of magnet schools has lead to higher mobility rates in the district. The two surveyed schools had not yet converted; students with a stronger academic focus went to the magnet schools.

Placement. Tracking takes place generally at the school level. District policy supports tracking through district standards that prescribe prerequisites for math and science courses.

Restructuring. The two district high schools we studied began the transition to magnets during our second semester of data collection. School M1 was to house an Environmental Sciences and Agribusiness magnet. M2 was to emphasize International Studies and Health Professions. Converting to magnets required closing one-half of the school building at a time for renovation. During this time half the school's students were placed in other schools to await completion of the construction at their "permanent" school.

The effect at M1 and M2 of becoming magnets will be discussed later. Here we note district level decisions that had important implications at the school level. Transforming all of the district's 16 high schools from traditional to magnet formats was a major undertaking. To make the task more manageable, the district decided to make the changes over a three-year period. Three schools would become magnets in 1988-89; 6 more were slated for the transition in 1989-90; and the other 7 high schools would be converted in 1990-91.

Many teachers and administrators believed there were distinct advantages to converting earlier rather than later. One benefit was that the first group had first choice of themes thought to be most attractive to the suburban, white, middle-class students whom the magnets were intended to attract into city schools. Second, many teachers and administrators believed highly motivated students in the second and third group of schools would transfer to the first operational magnets. Why would students wait two years for their neighborhood school to go magnet if they could enjoy the advantages of another magnet immediately? they asked.

If the teachers and principals we talked to were correct in their predictions, then it meant the first schools to go magnet were going to be "creaming" high achieving minority students from other schools in the district. It is therefore ironic that the two schools we studied were in the third group because they were already the two lowest achieving schools in the district. We will return to this issue when we discuss teachers' and administrators' expectations regarding the likely impact of going magnet for math and science instruction in their schools.

District Role. The district seems to use state guidelines as a starting point and sometimes exceeds what would be necessary for minimum compliance. Its high school graduation requirements are more stringent than the state's. It has recently produced extensive curriculum guides of its own accord.

The district administers the TAP, which appears to have a substantial impact on curriculum. The salience of the TAP exam can be explained by the fact that the federal courts use it as an accountability measure for allocating extra funds to the district under a desegregation order.

Missouri - Large Urban School (M1)

Evaluation. The School Board and administration use test scores as performance and accountability measures. We found no evidence that any teacher had been disciplined for failing to raise student test scores, but teachers reported feeling verbally "harassed" by administrators about the need to make explicit how test objectives were incorporated in daily lessons. Our impression was that administrators could make life difficult for teachers who they suspected were not doing all they could to raise test scores, though teachers did not lose their jobs as a result of low test scores. Some teachers resent the emphasis on student test scores as the basis for teacher evaluation because of the potential for teachers to be unfairly evaluated as a result of variations in the academic background of their students.

An assistant principal who regularly conducted observations reported that her main emphasis was on whether teachers were properly incorporating the TAP and MMAT objectives in their lessons. Each teacher was expected to post on their chalkboards those test objectives being covered in each day's lesson. Failure to do so was considered grounds for disciplinary action, although we heard of

217

no case in which such action had actually been taken. But this could not have been for want of cause; administrators indicated to us in the privacy of their office that they were aware that a small number of teachers performed inadequately in this and other areas.

Resources. Each school in the district receives $300,000 annually in desegregation funds to improve instructional programs. In 1989, each department at M1 received $18,000 from this fund. Departments have responsibility for determining how this money will be spent, although it must go for instructional supplies and equipment, not for extra salaries.

Although the desegregation monies are added to the normal operating budget, the years preceding the desegregation order were characterized by tight budgets and a dwindling stock of equipment and supplies. For this reason the math and science departments at M1 were not yet well equipped despite increased resources at the time of our study.

Other factors contributed to shortages of equipment and supplies. Many schools were troubled by theft and vandalism. At M1, a room full of Apple 2E computers had been stolen. Schools suffered another blow when the district failed to process requests for purchases before the deadline specified by the courts. In 1987-88 (when schools were allocated only $100,000 each in school improvement funds), the district managed to spend only about $3 million for school improvement projects, even though the courts had made $6.5 million available.

Students. Enrollment at M1 was at about 880 during 1989-90. In 1988, 62% of M1's students were African American, 5% were Hispanic, 31% were white, and the remainder were Native American and Asian. Official documents reported a daily average student attendance rate of 85%. The principal said 20% to 30% of all students miss at least one class on a given day. In the spring of 1990, an assistant principal reported that 270 of the 880 students enrolled in the school were failing four or more classes. In 1988, 35% of grades the school handed out were *F*s. No meaningful, official dropout rate was available, but the assistant principal told us that the school typically enrolled about 400 freshmen each fall and graduated about 135 to 145 seniors every spring.

MMAT scores at M1 rose between 1987 and 1990, but not as rapidly as they did in the state as a whole. On the TAP exam, the school showed little progress over the period from 1982-1990. In 1990, 9th graders scored in the 18th percentile nationally in math and the 21st percentile in science. At the same time 10th graders were at the 22nd and 19th percentiles in these same subjects, while the 11th grade came in at the 27th and 17th percentiles, and the 12th graders were at the 27th and 25th percentiles.

Particularly low scores among 9th and 10th graders may lend some strength to the claims of teachers and administrators that magnet schools elsewhere in the district had begun to "cream" high achieving students from M1. Furthermore, in anticipation of the transition to a districtwide magnet format, the district eliminated traditional school attendance areas for students during the 1989-90 school year. Under these conditions student mobility at M1 appeared to have reached a record high by the middle of March 1990; total enrollment had stayed between 860 and 890 the whole year, but 30% of the students attending in March were not ones who had been present in September.

Placement. Teachers and administrators describe the course sequences as options, rather than tracks. Although school personnel claim that children are not tracked based on ability, it is difficult to distinguish the sequencing system from a tracking system.

Teachers at M1 felt counselors did not make adequate efforts to abide by teacher recommendations in placing students. Teachers complained that counselors placed a higher priority on filling up the allotted classes within scheduling constraints than seeking to identify the best courses for individual students. Most teachers felt this resulted in students being placed in classes for which they were not yet ready. Although we heard this criticism of placement practices in most schools, teachers at M1 as well as M2 seemed more consistent in denouncing placement practices.

Restructuring. As noted in the above section on district policy, M1 was about to undergo conversion to an Environmental Sciences and Agribusiness magnet. Although the major effects of this change had not yet been manifested, the planning process had progressed to the point where the change loomed large in teachers' conversations. Virtually all teachers expressed support for the plan because they believed it would be accompanied by better equipment and supplies, smaller classes, better staff support, and higher salaries. However, none of the teachers we talked to thought the magnet format was going to attract a significant number of white students to the school or that academic achievement would rapidly improve.

Teachers' expectations about the negligible impact of the magnet plan on the racial composition of the school and academic achievement were based on two beliefs. First, teachers believed existing magnets had already captured the available market for suburban white students. Second, they believed a small but organizationally critical mass of high achievers was being depleted because their school was among the last to "go magnet."

School Role. School administrators and staff support the state key competencies and district curriculum guides. The math department chair said that the district guides help teachers concentrate on important content, and that the teachers in his department use them in developing curriculum. (Science guides are expected to be completed next year.)

We met several times with the curriculum coordinator for M1. Hers was the position created to ensure that one administrator in each school was monitoring alignment of curriculum with assessment to raise student achievement. She said that she actually spent little time on tasks specified in her job description because her building principal used her to help reduce the burden of traditional administrative chores on others. She documented convincingly the time she spent writing reports, doing budgets, monitoring attendance, and engaging in other administrative tasks that had no direct bearing on curriculum and instruction. Making the curriculum coordinator subordinate to the building principal thus interfered with the coordinator functioning as originally intended.

Guides. As the principal describes, "One must follow straight guidelines in terms of these objectives, and as you walk into a classroom in this building, you will see, and I'll be disappointed if you do not see, those objectives on the board . . ." The assistant principal responsible for curriculum alignment said she based teacher evaluations primarily on whether or not teachers were teaching MMAT and TAP objectives specified in district guides. She looks for articulation of test objectives in classroom observations and lesson plans.

The daily logs kept by RUC target teachers at M1 show teachers did not go sequentially through their textbooks or cover all sections of the text during the school year. This provides evidence that teachers may actually have been basing decisions about content on district curriculum guides; the guides require teachers to skip around in the text if they are to cover district objectives in order. At the very least, we know teachers did not rely heavily on textbooks for establishing the basic structure and scope of their courses.

Professional Development. Inservices and workshops at M1 had traditionally emphasized teaching methods and classroom management over math and science content. The conversion to a magnet format had the potential to change that. During the summer proceeding the RUC study, teachers at M1 were required to take 40-60 hours of inservice to remain on staff and qualify for increased salaries. One thing the inservices were intended to do was provide teachers with strategies for integrating the school's magnet theme into all aspects of the curriculum.

Testing. Administrators at M1 treated test scores as the primary measure of teacher and school performance and student achievement. This attitude was reinforced by central administrators who told principals, including those at M1 and M2, that their jobs depended on higher test scores. It was also buttressed by the school board who were having their collective feet held to the fire by the federal courts, the media, and community groups over poor performance.

The emphasis on testing yielded modest improvements for M1 in the two years preceding

RUC but backfired the year we were there. In 1989-90 the school placed heavy emphasis on objectives on which students had received low scores in 1988-89. Well after the start of the school year the school was informed of errors in the item-level data they had received on school performance on the TAP: for six months they had been emphasizing some objectives on which students had done relatively well and neglected others on which students had actually done poorly. To make matters worse, the 1989-90 version of the test did not emphasize precisely the same objectives as the 1988-89 exam. Apparently whatever students may have learned studying content from the 1988-89 tests did not transfer to the items on the 1989-90 exams; scores plunged in most areas.

Missouri - Large Urban School (M2)

The school takes a hierarchical approach to policy, with administrators pressuring teachers to align practice with state and district tests. The school operates under the same desegregation court order as M1 and thus is similarly accountable for test scores. Teachers are expected to know and teach the content specified in district curriculum objectives and covered on the TAP and MMAT.

Testing. Pressure from district and school administrators has resulted in heavy use of district and state tests and objectives to determine course content. School administrators order teachers to cover TAP objectives because the school is evaluated based on test results. In 1989-90, the principal instituted what one teacher called the "60-40 rule." The principal dictated that all math and science teachers with courses that related closely to tested objectives should spend 60% of their class time on the objectives while others were to spend 40% of their time on the objectives regardless of the traditional emphasis of their courses. Thus, for example, since the TAP exam emphasized physical science, physical science teachers were to spend 60% of their class time teaching objectives covered on the exam. Teachers in courses such as biology and ecology, who typically would spend little time on physical science, were told to spend 40% of their class teaching objectives from that content area.

Guides. District curriculum guides are meant to standardize practice, which school administrators view as a positive effect as opposed to before, when "everybody was doing their own thing." The principal characterized the math curriculum guide as one of the best district subject guides.

M2's administrators did not take the same concrete steps as M1's to encourage teachers to conform to district guides. For example, they did not monitor teachers' lesson plans for coverage of test objectives or hold numerous inservices and workshops on how best to align course content with tests.

In discussing M1, we noted that target teachers there appeared to be following district guides insofar as they were not going sequentially through their textbooks. At M2 however, three of four target teachers proceeded sequentially through their texts and therefore could not have been conforming to district guides. The target teacher who did not follow the text was the one who was most vocal about the negative impact of the 60-40 rule. Although he was ostensibly teaching biology, he used his biology text only 13 times in the entire school year. The rest of the year he taught TAP objectives that target physical science content.

The district and state both require extensive paperwork and a course of study to be approved before a school can offer a new class. The school had eliminated some general math and general science courses in the year preceding the study so that students would be forced to take physical science, but no new courses had been initiated.

Professional Development. The workshops conducted at M2 placed heavy emphasis on classroom management and pedagogy and rarely included subject area content. Unlike M1, workshops at M2 devoted little attention to curriculum alignment issues. Teachers at M2 agreed that workshops had little impact on what they taught.

Resources. The resource picture at M2 is the same as M1. District funding is based on student population. The state also provides substantial funds in compliance with the federal desegregation order. The desegregation plan focuses primarily on improving reading and math. As a result, funds are geared largely toward these areas, although other areas also receive some emphasis since the state test covers other subject areas as well. The desegregation order and funding run out in 1992.

The school has a computer lab with Apple 2E computers. The principal reported that the school has many more computers and students in computer science classes now than five years ago, prior to the desegregation order.

Students. The counselor characterized the student body as lower middle class. One administrator felt that "since 1978, the number of outstanding students had significantly declined." As was the case at M1, teachers at M2 felt that, because they were in the last group of schools to go magnet, they had lost out on competing for the good magnet themes and would be unable to attract suburban white students and high achieving minority students.

Placement. The science department chair reported that the school was using general science more than ever before at the time of our data collection; however, the district was about to make physical science a required course for all freshmen. This decision, as noted previously, was an attempt to align course sequences with the TAP exam.

There are few upper level courses taught at M2. A school administrator explained, "Our population has stabilized . . . there was no big need for upper level courses." The perception at M2 was that white flight and minority middle-class flight had left the school almost entirely with at-risk students. Being neck-in-neck with M1 for the worst test scores in the district reinforced teachers' perception that their students were simply incapable of achieving and the school itself was not in a position to change that.

Restructuring. M2 was scheduled to introduce a health magnet in 1990-91 and an international studies magnet in 1991-92. Six hundred students are expected to be enrolled in each magnet. Although M2 does not currently have resource teachers, they will acquire some when their magnet charter is fully instituted. At that time the implications of the magnet format for course content in math and science will be more evident. At this point it appears that math and science will remain central to curricula, at least in the health magnet.

School Role. The principal indicated that state and district policies have had a striking effect: "I feel that we've gone through a really big change in the last few years in the fact that we are emphasizing more science and math than ever before." The principal described the source of changes in the school as implementation of policy filtering down from the highest levels: "National pressure on the state, and the state on us, and the board on us, the central office on us, and then us on us."

Missouri - Smaller Rural District

This small district relies primarily on professional leadership to influence school curriculum decisions. As a district administrator remarked, "When I think of policy I think of something that is very formal and it is directed downward. We try not to get heavy into policy to the point that we really try to have policy as an outgrowth of how we work with our teachers and so forth. . . . Policy is observed as a real foreboding type of thing when it gets into directing instructions to the point that people then fight it. And then you win a battle, but you lose the war."

The district, according to their assistant superintendent for curriculum, is concentrating on creating a coordinated K-12 program. They are trying to "improve curriculum articulation."

The district recently hired an independent consultant to improve their curriculum. The board of education was the motivating force behind the initiative. The consultant gave the district twelve recommendations that the district is currently attempting to implement. One of the recommendations was that the curriculum should be better aligned to assessment.

The assistant superintendent indicated that he hopes the district will abolish classes such as functional math and refresher math. He feels that there should be higher expectations for noncollege bound students. However, he acknowledges that there are many individuals in the district who would prefer to maintain the current curriculum. In general, although critical thinking is being discussed, no changes have occurred.

Like some of the other smaller districts we looked at, this one called on department chairs to serve double duty as district curriculum specialists. Department chairs who served in this capacity were released from half their regular teaching load and received modestly higher salaries for their increased responsibilities. We were impressed with how efficiently the math and science chairs in this district moved among the classroom, department, school, and district contexts to coordinate math and science instruction in their school.

Testing. The district administers the MMAT to all students in grades 2 through 10 even though the state requires districts to administer the test at only four grade levels. The test was not well aligned with the curriculum, and students were being tested on material that had not yet been presented to them. The district was developing curriculum guides to better align curriculum with the state test. The science department chair indicated that he felt the MMAT had not changed practice significantly. However, testing did drive textbook selection, in that books were chosen based on their alignment with state objectives.

Guides. At the recommendation of the independent consultant, district curriculum guides were being revised to better reflect state MMAT objectives. In addition, the math department chair indicated that the new curriculum guides would incorporate some of the NCTM standards, such as using calculators, implementing problem solving strategies, incorporating computers, and estimating. The new guides were expected to be much more detailed and specific about course content than the ones in use at the time of our interviews in 1989-90.

The district curriculum guides in use during RUC data collection provided only the most general outlines for courses. According to an assistant superintendent, district curriculum guides specify student learning objectives and an approximation of how many days should be allocated to topics. The information for Algebra I fits on one and one-quarter double-spaced pages. Illustrative course objectives are: "solve linear equations," "evaluate functions," and "solve quadratic equations." The guide further advises teachers to spend approximately 10 class periods on addition and subtraction of whole numbers, 15 periods on measurement, 10 periods on equations and expressions, and so forth. The entire district mathematics curriculum guide, covering 18 courses in grades 7-12, is 28 pages long. The science guide covers 14 courses in about as much space.

The district makes no attempt to monitor whether classroom practice reflects what little is said about course content in the district guides. Departments are left to their own in determining which content will be included in which standard course offerings.

Requirements. The district requires two years of science and two years of math, which is the same as the state minimum requirements.

Textbooks. A district curriculum council is responsible for adopting textbooks. Previously, the departments adopted their own textbooks. One criterion for textbook selection is finding books that have the closest match to state assessments. A single textbook is adopted for both high schools in the district for a given course.

Professional Development. The district math coordinator reported that the influence of NCTM and area math organizations had grown in recent years, and more teachers were attending inservices than had in the past.

The district had a staff development center, but it did not relate to math or science specifically. Teachers sign up voluntarily for up to six half-day sessions. The sessions focus on effective instruction rather than specific subject content areas. Teachers who complete the staff development program may volunteer to engage in peer supervision. The district routinely provides release time to teachers for these activities.

In addition, the department chairs meet with teachers prior to the start of each semester. Occasionally, this time is used for content-specific staff development.

Evaluation. The district testing coordinator indicated that teachers are conscious of test scores and feel accountable for student test performance. As a result, curriculum is geared toward improving test performance. There are, however, no state or district uses of student test scores in the evaluation of teachers or schools.

Currently teacher evaluation is "performance based" and places heavy emphasis on classroom management and pedagogy. Teachers are observed twice annually in years one through five and once every third year thereafter. Teachers found to be unsatisfactory in any area must be given notice and an opportunity to take corrective action. Teachers took official evaluations seriously but did not find them instructive.

In addition to official evaluations, the district requires department chairs to make classroom visitations to spot check for problems.

Placement. The science department chair at M3 felt that the district did not officially influence the school's setting of prerequisites for taking certain courses. However, the assistant superintendent indicated that the district was not only tracking students, but it was "keeping those students from the opportunity of maybe being successful later on. . ." He said he would prefer to see less rigid tracking and felt that curriculum differentiation should be postponed to the latest possible point in students' schooling.

Resources. The district did not enjoy an influx of state dollars as did the urban Missouri district, but the rural district's tax base had come through the 1970s and 1980s in better shape than that of many other school districts. Between 1970 and 1990 the student population of the district went from 16,300 to 11,000. The drop in student population bottomed out around 1985 and is now recovering slowly.

The recessions of the late eighties and early nineties hit Missouri especially hard. As the district's enrollment and share of state funding dwindled, the district considered going to local voters for additional taxes. It did not, however, because families were hard pressed and already being taxed heavily to pay for the desegregation plan in the urban district studied by RUC.

District Role. Unlike its urban counterpart, this district was a minimal compliance district. It administered state tests, wrote skeletal curriculum guidelines taking state objectives into account, and maintained state graduation requirements, but it did not go much beyond these requirements.

Missouri - Smaller Suburban School (M3)

At M3, faculty and administration worked together to flesh out and implement general policies determined at the district and state level. The relative autonomy of the school from outside regulation was maximized by the active participation of teachers in district policy decision making. For example, both the math and science department chairs at M3 devoted half of their time to serving as district curriculum specialists. As such they were extremely well positioned to represent the interests and views of teachers at M3. Other teachers from M3 participated regularly on consequential district committees.

The school district was well informed about policy directions at the state level due to the leadership of a politically active superintendent. The small size of the district allowed for direct communication between the superintendent and M3's principal. The principal in turn was an efficient manager who worked closely with teachers. We were impressed with how smoothly and quickly decisions were moved along from individuals at one end of the educational hierarchy to the other. The small size of the district and school helped enable efficient implementation of decisions. Another factor was that faculty at M3 did not feel under pressure from the community over academic performance. The school had not been in the position of having to make radical changes or implement new policies on a short time line.

Testing. M3 administers the MMAT in ninth and tenth grade. Teachers at M3 said departments met once or twice each year to discuss student test performance and to make adjustments in content areas covered by various courses. The math faculty has compiled problem sets that teachers can use to give students practice on state objectives.

Guides. Target teachers and others said district curriculum guides had little impact on daily decisions about course content. This outcome is understandable given the brevity of the guides. The math target teachers at M3 tended to go through textbooks sequentially, seldom skipped pages, and seldom used secondary texts or teacher-made materials. Target teachers in science rarely backtracked in the textbook, but often skipped sections and frequently relied on filmstrips, secondary texts, and teacher-made materials instead of the primary text.

Professional Development. Teachers at M3 reported relatively positive experiences regarding professional development. The math target teachers had completed the district staff development program that enabled them to participate in peer supervision. They expressed strong support for the program and said it had impacted their teaching. It appeared that pedagogy rather than content was the main topic of concern in peer supervision.

The department chairs, who doubled as district curriculum specialists, reported that state and district workshops and university course work had been useful. Chairs may have been more attracted to workshops with a content emphasis than were other teachers because chairs were regularly involved in committees to align tests, texts, guides (especially the new ones), and course content. The math chair at M3 was much more familiar with the new NCTM *Standards* than were the chairs at M1 and M2.

Resources. Although the quality of physical facilities and equipment at M3 was about to be eclipsed by that of M1 and M2, M3 had superior resources at the time of our site visits. M3's library and computing lab facilities were more extensive and better utilized by science and math classes. The science classes at M3 met in lab-equipped rooms. The principal reported that the science department had recently received a special allocation of about $30,000 to get its equipment and supply inventory into shape. Science teachers at M3 reported spending 9.2% of their class time in labs, almost twice as much time as M1 science teachers, and nearly three times the amount reported by M2 science teachers.

In 1985 the district went voluntarily from a six- to a seven-period day. They did this to maintain enrollment in elective and vocational courses at the same time students took more credits in math and science. Increased math and science coursetaking was stimulated by increased college entrance requirements of the mid-1980s, and the belief that the state would soon increase graduation requirements for math and science.

Despite the salary increase given to teachers in the Missouri urban district under the federal desegregation plan, salaries were higher across the salary schedule at M3 as of 1989-90.

Students. M3 enrolled about 1500 students. The vast majority of students were white. Our impression was that Asian-Americans were the most represented racial minority group in the school. The counselor characterized the student population as middle-income, although he said the district had recently seen an increase in low-income students seeking to avoid inner-city schools in a neighboring district. We noticed that many students at M3 wore expensive clothes and drove cars to school, something not evident at M1 and M2.

Student achievement at M3 was above the state average in virtually every area on the state MMAT exam. In 1989, when the state average was 305 for math and 337 for science, M3 averaged scores of 325 in math and 388 in science. In a typical year, over 65% of the seniors at M3 take the

ACT. In 1988-89 graduating seniors who took the ACT scored at about the national average in all areas of the exam.

Placement. Most eighth graders in M3's district take Algebra. Those who do well (about 40%) go into Geometry in ninth grade. Others (about 30%) take Algebra I, or Prealgebra or Functional Math. College bound students take Algebra II after Geometry. Many then go on as seniors to take Calculus, Trigonometry, Probability and Statistics, or Analytic Geometry. In science, college bound freshmen (about 60%) take Physical Science, others take Principles of Science I. This is followed by Biology and one or both of Chemistry and Physics. Low achieving students typically stop taking science courses after completing Principles of Science II as sophomores.

Students select their own courses in math and science. Each student receives a booklet of course descriptions and is advised to consult with his or her parents in selecting courses. After consulting with a student's previous math or science teacher, or in cases of students who have particularly low test scores, a counselor may independently assign a student to a course other than the one the student has chosen. Counselors will change back to the student's preference if the student's parents insist.

Restructuring. The school has accommodated state and district level policy changes by making limited, incremental changes in organizational practice. No fundamental changes in curricula or programs were apparent.

School Role. M3 has been administered by the same principal for over 25 years and employs some teachers who began their careers teaching the parents of their current students. Continuity defined organizational practice, including instruction in math and science. Courses and course sequences have changed little in decades. Students have surpassed state minimums for graduation for decades and were little affected by recent changes. Neither district administration nor the community seems to place emphasis on the state test; teachers place a very low priority on teaching directly to the test.

The school's relative autonomy has evolved in a context where both state and district administrators have taken conscious steps to push as much decision making power as possible down the educational hierarchy. Administrators and teachers alike emphasized the importance of a committed and professional teaching staff, vested with autonomy and supported as necessary to make sound decisions about instructional practice. Compared to many schools in RUC, M3 was affected only modestly by the reforms of the eighties. This result can be explained in part by the fact that the school was relatively insulated against problems that beset some of the other schools studied in RUC, problems such as fiscal crises, racial tension between and among students and staff, and high rates of teacher and student mobility.

Pennsylvania

Pennsylvania has no state framework, no text adoption, and a weakened testing program. State subject matter supervisors describe their role as "helpful," "facilitating," "provide workshops and up-to-date information," rather than one of exercising state control.

There is no data system that systematically explores state impact on local schools, nor are state officials particularly interested in determining state impact. The state's most prescriptive policy is through setting specific competencies for teacher education. This general lack of state initiative in curriculum control may be changing; the Pennsylvania State Board is conducting forums around the state to see whether it can be more proactive in upgrading local curriculum.

Although Pennsylvania does not possess a coherent strategy for curriculum control, its role as facilitator seems to build local capacity. Perhaps the local educators do not feel threatened by state influence.

Testing. Pennsylvania once had a high-end assessment, but it was eliminated in 1987. The state has a basic skills test in reading and math called TELLS that is given once a year in March to grades 5 and 8. It is a minimum competency test that focuses on lower level skills, designed to identify students who need remedial work; state aid is provided for this remedial work. TELLS was subjected to heavy criticism because school-level scores were published in the newspaper and interpreted as a valid indicator of school performance. This practice tended to focus local policy on lower level skills. Consequently, the state remediation dollars that accompanied TELLS were eliminated, and the TELLS program is in the process of being revamped.

Frameworks. In keeping with its noninterventionist posture, Pennsylvania does not publish a state framework. There are recommended "competency continuums" for math and science published in 1987, but these are only advisory.

Requirements. Pennsylvania increased both math and science requirements from one to three credits in 1989. Pennsylvania does not keep course trend data, so there is no way to know the impact. Vocational Education courses can be used for both math and science requirements. Some districts believe the use of Vocational Education to satisfy state math and science requirements is frequent.

Textbooks. Districts adopt textbooks. The state plays no role in local text adoption and does not think that its curricular guides have much impact on local decisions.

Professional Development. The state has a wide array of staff development programs, but they are not articulated. The state requires each LEA to have a local staff development plan and does check to see whether that requirement is met. Eisenhower funds are used extensively in the state along with state funding to universities. However, the state does not monitor these programs to determine local impact. Staff development is a high priority for state staff in their facilitator role.

Pennsylvania - Large Urban District

Decisions in this district are often made at the district level, but with participation from administrators, teachers, department heads, principals, and parents. Consistent with this participatory style, but prompted in part by budget difficulties, district curriculum leadership has been cut back drastically in recent years.

Concerns about the quality and content of math and science education in professional associations and nationwide have influenced math and science instruction in the district. The district is very cognizant of the recently developed NCTM *Standards*, and the district has developed several collaborative programs with colleges and universities throughout the area in staff development in both mathematics and science. In addition, the district is in the process of offering Algebra and Prealgebra in eighth grade in every middle school by September 1990. Teachers are being trained for implementation of this curricular change.

Testing. Two tests are administered in this district: the standard citywide tests based on the city curriculum and the state TELLS test. Citywide criterion-referenced tests are used as midterm and final exams for all major math and science courses in the district high schools. (Some "minor" math courses such as Business Math are not tested.) The results of these exams count as 5 percent of the grade for each grading period (10 percent of the total grade for the year), and they are also used to encourage curricular alignment. The testing director is emphatic in pointing out that these tests are not used to evaluate teacher performance. Though this testing program was in place at the time of the study, it has since been eliminated.

Guides. The district developed curriculum guides in the mid-1980s. The district has created a standardized curriculum guide and pacing schedule in General Physical Science, Biology, Chemistry, and Physics. The guide and pacing schedule are aligned with the citywide tests. Curricular guides are based on widely used tests of the mid-1980s. They include a very specific pacing schedule that allows little time for science labs.

Teachers do not follow the pacing, but math/science teachers are more likely to use the guides than teachers in other subject areas.

Requirements. In response to increased state graduation requirements, the district recently added two third-year courses to the lower track curriculum: Math in Applications and Science and Technology. There are no curricular guides for the new science course.

Textbooks. Schools select textbooks from a district approved list. Committees in the various subject areas composed of department heads and teachers review the texts and develop an approved list of texts.

Professional Development. The district provides minimal staff development for teachers, allotting 14 hours per year per teacher for professional development activities. Only occasionally are teachers supported to attend state-sponsored programs.

The assistant superintendent stated that the district has a number of federal programs in which staff development is offered in math and science. PATHS/PRISM also offers summer institutes for teachers in math and science. During the year of our study, the district scheduled a two-day retreat for middle school and high school math and science teachers. The retreat addressed the standards set by NCTM and concerns of science teachers throughout the district.

Evaluation. The district mandates two observations a year, which focus on generic teaching methods rather than curricular content.

Resources. Personnel, course materials, computers, and calculators are scarce. The instructional facilities are antiquated but adequate. Most classes have an enrollment of over 30 students, and there is only one lab assistant for chemistry per school. There are no books for the Science and Technology course.

Restructuring. The Pew Charitable Trusts have funded some restructuring projects, creating schools within schools. These were in the first year of implementation in 1990-91.

Pennsylvania - Large Urban School (P1)

The district recently instituted a science magnet program in another school in the district in compliance with a federal desegregation order. The effect on P1 has been an outmigration of the strong math and science students. As a result, honors programs have been eliminated, and the academic atmosphere in math and science has deteriorated. Teachers report that students no longer have the background to complete advanced coursework in science and math.

Because Pennsylvania takes a hands-off approach to educational reform, there are few implementation issues to consider. The department chairs at P1 attempt to promote professional development among teachers in their departments. The science department chair makes announcements to staff about professional improvement opportunities. The math department chair expressed an interest in the NCTM recommendations but indicated that the school has insufficient resources to implement the NCTM plan. A teacher in the math department indicated that NCTM's emphasis on problem-solving had influenced her practice.

Guides. Teachers attempt to follow district guides and pacing schedules in order to improve student test scores. However, many teachers are unable to follow the pacing schedules because students cannot function at the district-prescribed pace: "My kids in 1982 or 1983 could have handled it. Kids with average or better ability that try the way they should, the pacing schedule would be perfect. The kids who are not used to functioning that well, then it poses a problem."

Teachers of the Science and Technology course are unaffected by district guidelines because there is no standardized test for this course. However, the science department chair thinks that by next year a standardized test will be created at the district level. He believes that, if such a test is created, then pacing will be instituted.

Text Adoption. Text selection is the responsibility of the department chair. The district identifies a list of acceptable texts and the department chair chooses books from this list. The science department chair at P1 involves teachers in the decision. He narrows the selection to three or four books and invites publishers in to present the books to the teachers for their input.

Professional Development. The local math association is very active and provides information and workshops to teachers on various topics.

Evaluation. The department chair performs evaluations based on district guidelines. Teachers are observed at least twice a year by administrators and at least twice a year by the department chairs. The department chair admitted that although he was "supposed to do observation for the purpose of instructional improvement . . . most of (his) efforts are spent on those teachers having serious control problems."

The union handbook precludes department chair evaluations from being used as official ratings of teachers. However, if a department chair gives an unfavorable rating, it begins a process of evaluation of the problem teacher involving school and then district administrators.

Resources. Resources at P1 are very scarce. In this atmosphere, loss of textbooks has become an important resources issue. The science department chair reported the following: "For a short time I kept a log on the computer of any student that didn't turn in a book--how much it cost. I only kept it for three years. At the end of the three years, the school had lost over $25,000 in books. I only get $5000 for the whole department per year. A good biology book costs $30, so a class set costs $1000. With nine science teachers, each having 5 classes, I have enough money to get books for about 1/9 of the classes. Books are the hardest thing. They eat into the budget so much that everything else pales [in comparison]. . ."

P1 has one lab assistant who prepares chemistry labs and distributes supplies and films to the entire science department.

Students. P1 is located in a poor urban area. One incident gives a general sense of the school's neighborhood: the research team's car, which was parked in front of the school, was stolen during the day. Few students take the SAT or go on to college.

With the advent of a science magnet at another school in the district, the ability and interest level in math and science has declined. Students don't see science as having any relevance to their lives. Many students are intimidated by science courses, particularly chemistry and physics. Many students have tremendous deficits in math. The science department chair reported that his physics students struggle with even basic multiplication.

One teacher said that student achievement does show improvement over the school year. But over the past few years, the atmosphere at the school has gotten worse. Student achievement has declined and student apathy has grown.

Placement. According to the science department chair, P1 does not track students. In science, there are no AP, honors, or rapid classes. Although some courses are labeled academic and others are labeled general, there is no difference in the courses. The different labels simply allow students to register with like-minded students. Students decide on their own whether to enroll in an "academic" class.

The typical science sequence is Physical Science (9th), Biology (10th), and Science and Technology (11th and 12th), but these courses are often taken out of order. There are no prerequisites for the nonacademic "track." In ninth grade, students are placed automatically by the computer into 9th-grade courses and are heterogeneously grouped. In 10th grade, they are placed into Biology. In 11th grade, with the guidance of the counselor, students are allowed to choose between Chemistry, if they are more academic, or Science and Technology if they are not. A few students continue on to take Physics in 12th grade. Teachers may move students in or out of academic classes early in the year. If a student doesn't pass one of the first three courses, they must repeat it or make it up in summer school or night school; they need three credits to graduate.

In math, the normal sequence is General Math or Algebra I, Geometry, and Elementary Functions. Students are placed according to their performance in the previous course. Algebra honors students go to Honors Geometry if they perform well in Algebra I; if not, they drop back to Basic Geometry. A teacher recommendation is necessary for a student to be placed in honors courses.

Some teachers feel kids are being pushed into Algebra I who are not prepared for it. Schools in the district are considering abolishing General Math but have not decided yet to put all kids in Algebra.

It is rare for students to change from general to academic courses unless they were misplaced at first.

Restructuring. According to the science department chair, when the magnet school program was started in the district, there was a considerable drop in the science program at P1. "Once the cream was skimmed off, it reduced all the classes to general type classes. In the past we have had academic classes. Those became fewer and fewer because we were sort of fooling ourselves by calling the high end of the low group academic when actually, they are the high end of the low group. The low end of the high group is gone already. I haven't seen a kid score a thousand on the SAT the whole time I have been here."

School Role. When teachers feel it is feasible given student ability levels, they follow closely the district curriculum guides and pacing schedule. However, since the creation of the magnet in the district, many academically oriented students have been drawn away from P1. This change has resulted in a decline in the ability level of the student body and an increase in teacher perception that the district pacing schedule is simply unrealistic. Nonetheless, pressures to perform on district tests have led teachers to utilize the guidelines in curriculum development.

Pennsylvania - Large Urban School (P2)

P2 is an administratively centralized school with teacher seniority playing an important role in distribution of power and authority within the ranks of teachers in the school. For example, department chairs and administrators make final decisions on teacher assignments, with teacher seniority playing a crucial role if there is a dispute.

Testing. At P2, one teacher indicated that the district test plays a role in influencing what is taught but does not always dictate curriculum. He added that he tried to cover any material on the district test at the end of the year that had not yet been covered during the course of the year.

Guides. District curriculum guides, which are aligned with the district tests, tend to dictate what is taught. One science teacher said, "I follow the district's standard curriculum which follows the text. I try to follow the pacing schedule. I like the structure it gives me."

Textbooks. The school selects textbooks from a district approved list.

Professional Development. Although inservices are offered, one teacher indicated that he did not find them helpful and generally choose not to attend. "They do have these inservice type things sometimes, but I never go. I've taken enough courses I think. Last year there was a workshop on mathematical games that I went to, but I haven't integrated it into my course."

Evaluation. Teachers are observed twice annually by administrators and three to four times a year by the department chair. The district provides a formal evaluation sheet. The administration relies heavily on the department chair to insure that district level objectives are met. The results of the citywide midterm and final exams also help determine whether a teacher is meeting district objectives. These evaluations are intended to ensure satisfactory performance, to determine whether curriculum guides are being followed, and to offer assistance where needed.

Resources. Resources are divided among teachers by the department. Current lab facilities are inadequate. However, plans have been made to create new lab facilities.

Students. Two percent of the student body participates in the Honors program in order to enter a four-year college.

Placement. P2 has a more conventional tracking system than P1 and uses test scores to determine math placement in the Rapid, Average, and Business tracks and the magnet program. Students in the upper track are more likely to participate in hands on science work and experimentation.

Students are initially assigned to tracks according to CTBS scores in the 8th grade and citywide test scores. Counselors are directly involved in student course selection and recommend strategies in student placement. Teachers are being consulted more about which students should go into academic and which into general classes; teachers give lists of suggested changes to guidance counselors. However, teachers have no direct role in student placement. Students stay in their assigned track unless parents ask for a change.

Restructuring. There is a special "motivation program" for 10 percent of the student body that is housed in a separate building and features academic courses.

School Role. Although school administrators encourage teachers to follow district curriculum guidelines, some teachers are concerned that the amount of material covered in the guides is so large that teachers concentrate more on teaching the curriculum than on teaching students. Nonetheless, at least one teacher felt that the district test does not dominate instruction. He pointed out that covering the required material for sixty questions "isn't going to cover the whole gambit of what you are going to teach."

Pennsylvania - Smaller Rural District

The district influences math and science curriculum through mandates, such as district tests, and through development of curriculum guidelines that are aligned with the tests. The district has eliminated basic science and math courses for freshman students.

In 1989, the district combined concepts of biological science, physical science, and environmental science into Advanced General Science throughout the district. According to the assistant superintendent, other new science classes include AIDS, environment, sex, drugs, and parenting education.

Recent national attention to math and science education has influenced district curricula to focus more on problem solving, including increasing use of calculators, and less on computation.

Testing. The district administers five tests: the CTBS (in October and May), the state TELLS test, a districtwide subject area test, the PA Assessment test, and the PSAT. The district test is the test most closely aligned with district curriculum guidelines. Although students typically do poorly on it, the TELLS test also has some alignment with district guidelines. Teachers incorporate the students' test results on the districtwide tests into their final grades. The districtwide Biology test was constructed three years ago.

Guides. Most teachers cited district guidelines as a primary force that determined what they would teach. For example, a science teacher in the district indicated that he uses the state competency continuum for basic guidance but depends on the district guide to a greater extent; neither has a large effect on his own practice.

Requirements. District administrators indicated that the state increase in high school graduation requirements has been one of the largest influences on math and science education in recent years. In this district, the three years of mathematics must include Basic Algebra and Basic Geometry.

Textbooks. In this district, teacher committees select textbooks. It appears that the district curriculum guidelines are based largely, if not entirely, on the district's textbook selections. According to a math teacher: "I was involved in the teacher curriculum guide committee and all we did was use the table of contents from the district textbook to generate the curriculum guide."

Professional Development. The district does offer inservices for teachers to improve their instructional techniques or content knowledge. One math teacher who attended district inservice workshops on computers said that she did not feel that they helped her with her teaching assignments. Similarly, one of the science teachers reported that he did not feel that these inservices influenced the content that he presented to his students in class.

Students. Students in the district score poorly on tests. CTBS scores and scores on TELLS, on average, are declining. In contrast, however, one district administrator indicated that 20% more students are taking the SAT/ACT than have in the past.

Placement. The district does have a tracking program, in which students are placed according to their performance in previous courses and, to a lesser extent, teacher recommendations. In the fall of 1988, the district began to require that everyone take Basic Algebra and Basic Geometry. Previously, high risk students took the Math 9, 10, 11 series. Eighth graders who are doing extremely well may be placed in Honors Algebra I or Algebra 2C if they have taken Algebra I in eighth grade. Teacher permission is necessary to enroll in Honors Algebra, and students must maintain an A or B to stay in the Honors track.

One math teacher indicated that the requirement that all students take Basic Algebra and Geometry effectively put the same kids previously taking General Math into Algebra without any additional support services.

Pennsylvania - Smaller Urban School (P3)

P3 had added three new electives: Concepts of Biological Science, Physical Science, and Environmental Science. In 1989, these three were merged into Advanced General Science as result of a district decision. Other recent course additions include Basic Algebra and Basic Geometry, which are now required. Math 9A was added to serve remedial students who could not take Basic Algebra.

Professional Development. Although teachers reported that they attended district inservice workshops, in general, they did not feel that these inservices influenced teaching practice.

Students. The school serves a low-income urban population, including three different housing projects. Many students are the product of fragmented families, and half of the students receive free or reduced-price lunches. The school counselor said, "We deal with students who come here with lots of difficulty and disadvantages."

P3 has a tracking system with an academic and nonacademic track. The school counselor uses teacher recommendations and class performance to place incoming eighth graders. Students continue in their initial track, with 10th, 11th, and 12th graders placed according to their previous courses.

In math, unless ninth graders have low test scores and are failing, they are placed in Basic Algebra (6 sections). Ninth graders who are doing extremely well may be placed in Honors Algebra I (1 section) or Algebra 2c if they take Algebra I in eighth grade. Approximately 30 at-risk students take basic math, 9A, in ninth grade instead of algebra.

In 10th grade, students take either Basic Geometry or Honors Geometry. In 11th grade, students in the regular track take Algebra II or Consumer Math. Those in the Honors track take Algebra II/Trigonometry. In 12th grade, 60% of the students do not take math. Those that elect to take math usually take AP Calculus, Introduction to Analysis, or Trigonometry.

In science, ninth graders take either regular or honors Earth and Space except the students in basic math 9A who take General Science. In tenth grade, students take either regular or honors Biology. In eleventh grade, students take either regular, honors, or AP Chemistry or Advanced General Science. Finally, in 12th grade, students who continue in science take either regular or AP Physics or AP Biology.

School Role. Per district mandate, district tests are used as midterm and final exams in courses taught at P3 and are used in the evaluation of school performance. District curriculum guidelines are aligned with the test and the textbooks. Teachers have strong incentives to use the district guidelines in determining what is taught. However, teachers indicated that they were able to gear teaching to student needs.

South Carolina[1]

South Carolina has a strong top-down strategy relying on mandates and incentives to standardize practice to cover basic skill areas. Thirty-six basic areas are to be covered in preparing students for the state basic skills exam. Students are required to pass the basic skills test in order to graduate. South Carolina is considering revising its basic skills test to emphasize higher-order thinking; however, the current state strategy does not focus on shifting practice in that direction.

The major policy initiative in South Carolina is the Education Improvement Act (EIA) of 1984. The EIA is intended to raise student achievement, especially as measured by standardized basic skills tests. The main components of the program are the Basic Skills Assessment Program (BSAP), the School Incentive Reward Program (SIRP), the Teacher Incentive Program (TIP), and the Principal Incentive Program (PIP). The state uses the BSAP to focus schools' attention on particular basic skills content knowledge. Exam performance is consequential to students; they cannot graduate without passing the tenth-grade BSAP. It is important to teachers; they receive \$1500 - \$2500 cash bonuses for contributing to improved test scores. It is important for schools; they receive substantial funding bonuses for high scores. Principals in successful schools also receive bonuses of \$2500 - \$5000. Districts that perform poorly may be deemed "educationally impaired" and be ordered by the state to implement specific corrective measures before resuming a normal level of control over their own school system. Impaired districts may lose some or all of the funds allocated under the EIA.

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[1] Chapter 4 presents detailed case studies of the state, district, and schools in South Carolina. This section may be skipped for those who read Chapter 4.

The state funded the EIA initiative by raising the state sales tax from four cents on the dollar to five. The extra penny was set aside solely for public education. This measure has amounted, on average, to an additional $200 million annually for public education. Total state expenditures for education rose from $799 million in 1982-83, the year before EIA, to about $1.2 billion in 1986-87.

Testing. South Carolina mandates that all students take the Basic Skills Assessment Program (BSAP) test in grades 1, 2, 3, 6, 8, and 10. The BSAP at grades 3, 6, and 8 includes a science section. Mathematics is a part of testing at all grade levels. BSAP math subtests have two parts: Part I tests students on isolated skills (e.g., add two simple fractions, divide with two three-digit whole numbers); Part II consists of application items for which students must determine for themselves what operations are appropriate to the task. Application items in math are usually simple word problems and can be completed using the same algorithms that are directly tested in Part I of the exam.

In science, students are tested on concepts in life, earth/space, and physical science; process skills (e.g., collecting data, formulating and testing hypotheses); science and technology; and the nature of science. All items are multiple choice with four possible responses. Some items require students to use their knowledge to interpret graphs and diagrams, others question them directly on concepts, asking which of the alternatives offered represents the "best" example of a certain kind of statement or idea.

The tenth-grade exit exam covers math, reading, and writing. Students who do not pass the BSAP exit exam have four more opportunities to pass the test before graduation. Students in the freshman class of 1986 were the first ones to be required to pass the tenth-grade BSAP prior to graduation. The BSAP was given for the first time in 1980-81 but did not assume great importance for individual students, teachers, and administrators until it was incorporated in the EIA in 1984.

The state also requires districts to administer the Stanford-8 norm-referenced test in grades 4, 5, 7, 9, and 11. In grades 9 and 11 only reading, math, and English are tested. Stanford-8 scores are used along with BSAP scores in determining SIRP and TIP awards.

State testing has a large impact on some classroom teachers, especially those in lower-level high school math courses. Criticisms of the BSAP are that it does not give teachers item-level data and thus cannot be used to guide instruction; it generates an unreasonable amount of paperwork; and it places too much emphasis on testing basic skills. In Spring 1991, South Carolina was developing an alternative BSAP exam aligned more closely with NCTM *Standards*. State testing specialists were uncertain about whether a new test, if eventually produced, would be implemented.

Frameworks. The state distributes a manual called Teaching and Testing our Basic Skills (T&T) to its districts to help them prepare students for the BSAP. The T&T manual specifies objectives and provides suggestions on how to teach basic skills content. The high school version of T&T was written in 1981-82. The science version was redone in 1985.

Requirements. South Carolina requires that all high school students complete three years of math and two years of science in addition to passing the BSAP exit exam in order to graduate. This represents an increase in requirements of one year in each subject. The defined minimum program regulation requires that at least 20% of science instructional time be laboratory time. The University of South Carolina requires high school students to complete three years of math (Algebra I, Geometry and Algebra II) and two years of lab science in order to be eligible for admission.

Textbooks. South Carolina approves textbooks on a statewide level. State-approved books for each subject area are purchased by the state for the districts. If a district wants to use a nonapproved book, it must find its own funding.

The state Textbook and Curriculum Advisory Committee, comprised of 14 members, makes recommendations concerning textbook adoptions/replacements to the State Board of Education. Meetings of the committee are held annually with additional meetings scheduled if necessary. The State Board with the help of the State Superintendent of Education appoints an Evaluating and Rating Committee (9-12 teachers, administrators, and laypersons) for each major subject area to evaluate the Textbook and Curriculum Advisory Committee recommendations. A smaller Evaluating and Rating Committee is used for subject areas with less than 2,000 students. The Evaluating and Rating Committee places books on the recommended list by a 2/3 vote. In addition, the books must meet the "South Carolina Official Manufacturing Standards and Specifications for Textbooks," although exceptions are sometimes made. The standards for textbooks are drawn up by state committees. In the past, the state has used textbook standards and specifications to convey to publishers the importance of expunging overtly racist statements from their texts. The state emphasizes the importance of basic skills in its current specifications.

The State Board must adopt at least three and not more than five books in each subject, but exceptions to the 5-book rule can be made with the approval of the Evaluating and Rating Committee and the Board of Education. Book contracts are for a period of 4 years and contain a clause that allows the State Board to extend the contract for 1-2 additional years at a renegotiated price. State curriculum specialists who served on textbook adoption committees for mathematics said the then new NCTM *Standards* influenced the mathematics text adoption process. Although the NCTM *Standards* were not seen to provide definitive criteria for textbook selection, math curriculum specialists said books were explicitly examined for their treatment of application and problem solving as well as basic skills such as computation.

South Carolina - Large Urban District

The district has some leadership problems because of a power struggle in the Board of Education and the current lack of a superintendent. These factors have reduced the impact of the district on school curriculum policy. Nonetheless, the district influences the math and science curriculum through a testing program that will soon include district Area Exams. In addition, the district has developed curriculum guides aligned with the testing program.

Testing. The district administers the state BSAP and the Stanford-8 achievement test. The BSAP exam takes three days in tenth grade and the Stanford test battery takes five days in grades 9 and 11.

The district also administers district Area Exams in Algebra I and General Math I that are used as final exams. A student must receive a passing score on the test to receive credit for the class. The district is in the process of developing a physical science exam, and other subjects are expected to follow. Some teachers feel that the Area Exams put too much pressure on students. Others see Area Exams as a positive force because they believe the exams reduce variation in curricular coverage.

The district Area Exams that were in use by the time of our fieldwork were having substantial impact on students. For example, in 1990-91, the failure rate for students who took the district Area Exams for General Math I and Algebra I were 18% and 25% respectively. District curriculum specialists aligned exam content to district curriculum guides. Many of the math guides, including the General Math and Algebra I guides, however, had recently been revised to incorporate more NCTM-like content. This meant the district Area Exams contained a greater proportion of difficult problem solving and application items than tests to which students and teachers were accustomed (e.g., the BSAP). District curriculum specialists for math and science attributed the high failure rate on district Area Exams to the fact that teachers did not adhere to curriculum guides as required by district policy.

Guides. The district has a series of detailed curriculum guides for each subject. Each guide provides objectives, activities, suggested instructional materials, and assessment methods. Guides also indicate to teachers which content is covered on state and district tests. Guides are revised about every five years when new textbooks are adopted. The district had recently completed revising math guides in line with the NCTM *Standards*. The chemistry guide was also being revised to place greater emphasis on problem solving and application.

District policy permits teachers to add material to course curricula, provided they cover everything in the district guide. The assistant superintendent indicated that actual implementation of the curriculum guides varies from school to school depending on the level of monitoring done by the principal. Overall, she estimates that 75% of teachers follow the guides. In contrast, the curriculum specialist for math estimated that only 25% of all math teachers utilize the guides, adding that this low percentage partly accounts for the high student failure rate on district Area Exams.

Requirements. The district requires the state minimum three units in math and two in science for the high school diploma. The district also offers a college prep diploma as required by the state; the college prep diploma requires four courses in math and three in science.

Textbooks. The district selects textbooks from the state list, and schools must use the district selection. Once a district has made its selections, the state makes the actual purchase and distributes the books to the schools. The district tries to use only one textbook per subject area for the entire district since administrators feel it is easier to align curriculum and provide inservices when there is only one book. In addition, having only one textbook makes it easier for students who transfer from one school in the district to another during the school year.

Professional Development. According to the assistant superintendent, the district has five inservice days, 2.5 of which are school planned. Teachers may also get reimbursed once every two years for college credit courses they take in their subject area.

The district uses Eisenhower funds to bring in consultants at the district level and send teachers to professional meetings. Teachers are asked to relay the information that they have learned to other teachers. The district curriculum specialist estimates that all math and science teachers receive some staff development benefits from Eisenhower funds, especially in light of the sharing of information by participating teachers.

Resources. This district lacks sufficient funds to upgrade facilities. In addition, the average teacher salary for the district is about $2,000 below that of the surrounding districts. The EIA initiative has increased state money for district schools and thus eased the severity of fiscal shortages. However, because a substantial percentage of school district funds in South Carolina comes from local taxes, and because this district is relatively poor, district schools do not enjoy the same high level of funding found in some others.

Evaluation. The district's Teacher Assessment Program (TAP) is designed according to state regulations. Teachers with "provisional" or "annual" licenses are evaluated each year and must be observed at least twice. "Continuing" licensees are evaluated every third year. Evaluators include principals, assistant principals, and central office staff. At least one of the teacher observations must be conducted by central office staff.

All teachers receive a 100-page manual that specifies the behaviors and documentation (e.g., lesson plans, letters to parents, grade books) upon which evaluations will be based. Evaluators must forward evaluation summaries to the district. Teachers who fail to achieve a minimum score in any area for any of the required observations must be observed again. Teachers who fail in follow-up observations must be "remediated" by school administrators in order to receive a contract for the following school year.

TAP evaluations are based on the five performance areas of planning, instruction, classroom management, communication, and adherence to district policy. Teachers must earn at least 208 of 248 possible points on evaluations to be deemed "professionally competent." Furthermore, teachers must score above 80% in each of the five performance areas. The specific behaviors assessed emphasize pedagogy and bureaucratic procedure and relate little to content.

The evaluation instrument specifies about 50 desirable teacher behaviors, called evaluation "criteria," across the five performance areas. Only one of the criteria makes direct reference to curricular content; the observer is to assess whether the lesson "reflects use of [district] curriculum guides or state or federal regulations." Teachers stand to lose only 3 points, or 1.2% of the 248 points possible, if they fail to satisfy this criterion; course content is essentially ignored in teacher evaluations.

Placement. The district recently recommended that schools change the order of math classes from Algebra 1, Geometry, Algebra 2, to Algebra 1, Algebra 2, Geometry, and that Practical Biology be eliminated. These recommendations were made to better align curricula with the state test.

After the state began requiring students to pass the BSAP for graduation, remedial reading and remedial math courses were added. Test scores influence placement into remedial programs. Upper level courses have not been affected, since the focus of BSAP is on students at the lower tier.

South Carolina - Large Urban School (S1)

The school has a site-based management model. School administrators view their role as staying out of the way of teachers who are doing a good job and supporting teachers who need extra help. Faculty reported that the principal is very responsive to teacher needs and opinions.

Testing. One math teacher stated that the district Area Exams put a lot of pressure on teachers to teach the right thing. Although she feels that the tests should not count as much as they do, she is in favor of the exams. In addition, she used to feel pressure from school and district administrators to have all her calculus students pass the AP Calculus exam. She spoke with the principal and expressed her belief that a student who does not pass the AP is not necessarily a student who cannot learn calculus. The principal decided that he could live with low AP test scores, allowing for slightly higher enrollment in the AP Calculus class.

Guides. State objectives, which cover only content tested on the BSAP, have much impact on curricula for math classes up to and including high school general math and for Physical Science. Although the BSAP has no Algebra on it, Algebra 1 teachers may spend much time on BSAP content because many of their students come to them lacking the skills necessary to pass the BSAP exit exam. This lack is particularly true in low achieving schools, such as S1, in which a large percentage of students placed in Algebra 1 are likely to fail the BSAP exit exam on their first attempt.

A physical science teacher at S1 expressed ambivalence about the role of the curriculum guides, "The problem is that there are so many of them [specific objectives in the curriculum guide] that it is almost like I have to cover the [entire] textbook, and I think that is a real disadvantage for this course." Nevertheless, she adhered closely to the guide because the district was about to pilot a new Area Exam for Physical Science with her classes.

Professional Development. School workshops and inservices usually focus on pedagogy. However, some teachers indicated that they would prefer an emphasis on content.

Evaluation. At S1, teachers submit lesson plans to the department chairs. Teachers are formally evaluated using the district's Teacher Assessment Program. This program conforms to the state requirement to evaluate new teachers annually for the first three years and all others in each third year. Teachers did not express strong opinions specifically about the district evaluation system. There was, however, a general perception that the evaluations were rarely consequential to individual teachers.

Resources. Starting in 1991-92, S1 intended to reformat its remedial programs to qualify for more state and federal funds. Some of the money was expected to be used to invest $30,000 in computers for remedial math instruction.

Departments at S1 collect student fees at their own discretion to use for purchasing instructional materials. Most departments charged students $2.00. The science department set a somewhat higher fee, $3.00 to $5.00 dollars annually. In the past, departments received modest amounts of money from the school and district, but there had been almost no money for equipment and supplies for the two or three years preceding our study. When faced with inadequate funds for equipment and supplies, the principal adopted a strategy of not funding departments such as English and social studies so that science and vocational education could have basic supplies. The principal said that some schools have generated equipment and supply funds by setting up large banks of vending machines in the school cafeteria; the district allows schools to retain vending proceeds for expenditure at the school level. Schools are also allowed to use receipts from athletic events for school improvement expenditures. However, S1's principal said these strategies provide little relief in relatively small low-income schools such as S1.

One math teacher indicated that resources are adequate even though there is nothing for extras. Science teachers felt that supplies were scarce. They felt they spent a significant amount of class time doing labs, but not as much as the state required. The chemistry teacher got the most out of lab demonstrations by using a video camera and monitors to enable all students to have a good view of what he was demonstrating. The money for the video equipment came directly from the district, not out of the normal operating budget.

Students. The state education agency places S1 in the second lowest quintile in the state with respect to income. The school counselor estimates that 60% of the students are from low-income backgrounds, 20% from middle, and 20% from high. She said the student population had been predominately middle income until the mid-1980s, but "white flight" surged between 1985 and 1987.

Placement. S1 has three placement tracks: general, vocational, and college prep. General track and vocational track students take General Math 1, 2, and 3, General Physical Science, and General Biology. As of 1991-92, freshmen general track students will take General Science instead of General Physical Science. College prep students take Algebra 1, Geometry, Algebra 2, Precalculus, and Calculus; and college prep or honors Physical Science, Biology, Chemistry, and Physics.

At S1, about 35% of the students are college prep, 30% are in the general track, and the rest are in the vocational track. About 50% of freshmen used to begin the college prep track. However, since counselors began advising students that "college is not for everybody" and encouraging them to pursue technical careers, the college prep track has diminished in size. The school counselor said the department decided to reduce the size of the college prep track because teachers complained that many student were in courses for which they were not well prepared. The counselor said she felt the change in the placement system was working well since it prevented students from being put in courses where failure was almost certain.

Test scores influence placement into Chapter 1 and state BSAP-related remedial programs. At S1, the school tries to pull all students who need remedial work in math, reading, and writing (BSAP-tested areas) from the regular classroom in order to give them extra help. Achievement test scores influence placement into honors level science courses. Students who do not have high reading and math scores on the Stanford-8 are not considered capable of succeeding in honors science.

Generally, guidance counselors base recommendations for placement on prior grades, but parents can have a strong influence on where their children will be placed. Some teachers, especially in the science department, thought counselors should rely mainly on teacher recommendations for student placement. The concern motivating science teachers' criticism of existing placement practices was that, in their view, too many students were being placed in courses for which they lacked prerequisite skills. Teachers feared they were being pressured to choose between watering-down the curriculum and failing large numbers of students.

Restructuring. One math teacher felt that the school-based management approach under the previous principal did not work since he used school-based management as a scapegoat. Under the new principal, the approach seems to work better because the principal is widely perceived as being responsive to teacher needs and opinions.

School Role. Teachers at S1 were critical of the leadership of their local school board, which was pushing for higher standards. Concerned by a marked shift in the community toward a poorer student population, a major issue for them was how to divert greater proportions of students into less academically rigorous courses. The principal, based on his understanding of the district's site-based management model, appeared ready to facilitate the change teachers desired. Perhaps because it was his first year at the helm, the principal wanted to establish a positive relationship with staff. Having worked under a principal they disliked for several years immediately preceding our study, teachers were anxious to have a stronger voice in school decision making and improve their working conditions.

South Carolina - Large Urban School (S2)

S2 is a large comprehensive high school with ancillary programs for adult education and at-risk students. The school also houses a districtwide academic magnet school that has its own staff and administrator. Math and science programs are treated on a par with other subjects, receiving no special consideration. The principal supports most district policy, especially student and teacher accountability measures. He liked the state BSAP exam, although it had been several years since his school last scored well enough to receive SIRP or TIP awards.

Testing. Some teachers expressed concern that district Area Exams caused unnecessary stress on students. However, the math department chair indicated that she felt the Area Exams are a necessary evil that will help with placement decisions, since there are many students who are being incorrectly placed.

Guides. The degree to which teachers follow the district curriculum guides varies significantly. Some teachers follow the guides closely, some change the order, and others resent the guides and avoid following them if at all possible. One science teacher stated that she follows the district curriculum guide and this means using the book out of sequence. A math teacher at the school said that he follows the district curriculum guide in terms of content covered but sometimes changes the order. He tries to work within all of the guidelines (state and district) as well as keep in mind student needs. His primary concern is to identify course content that will enable students to score well on the SAT and gain admission to the state university.

Generally speaking, though teachers adhered to the district guidelines to varying degrees, all teachers were aware of their existence. Some teachers complained that there were too many objectives to cover them all and ensure student understanding.

The General Science teacher said that she finds teaching easier because there is no curriculum guide for General Science. "The curriculum guide [for Physical Science] is hell. . . . We all hate it because it doesn't go in the order of the book and it blends different chapters." Because of this, some teachers do not follow the curriculum guides and, instead, follow the order of the textbook.

Professional Development. At S2, science inservices tend to be content-oriented. However, one teacher complained that she would prefer to have the inservices focus on laboratory techniques and pedagogy. She does not think it is worth looking into new topics because just going through the book is enough of a challenge.

Evaluation. At S2, the principal does formal observations as required by the district and state. Teachers did not believe the district evaluations were consequential. Some teachers said administrators' informal impressions of individual faculty members sometimes led principals to interact with the teacher in a way that helped or interfered with the teacher's daily work and affected the teacher's job satisfaction.

Resources. S2 uses state funds to run a reading and math computer lab for students who score low on the state BSAP and Stanford-8. S2 received $105,000 in state remediation money. However, according to school officials, this amount is not nearly adequate to keep class size down to the desired level of 20 students.

Both math and science teachers complained of inadequate resources. The lack of resources is particularly apparent in the science department. The science budget for the study year was $1700, which is insufficient to purchase supplies for laboratories. In addition, teachers indicated that lab space is inadequate and is shared with the magnet school located on the same campus.

The department head allocates to each teacher in the science department the same amount of money regardless of class size or course. However, the department as a whole decides how money will be allocated for supplies and chemicals. The district is buying the department a computer, since many of the textbooks have computer-related tests.

Some school administrators do not feel that resources are being distributed fairly. The state policy of rewarding schools with high test scores creates a situation in which "the rich get richer and the poor remain the same." Without additional resources, it is difficult for poor schools like S2 to increase test scores.

Students. Students at S2 are from low SES backgrounds. Virtually all students are African American. One teacher characterized the lack of motivation among the students as one of the major problems at S2. More common was the complaint that students were often forced to work too much to maintain themselves or help with family expenses.

Scores on the BSAP exit exam have gone from slightly better than 33% of students passing two of three parts of the exam to about 70% passing all three parts in three years. At S2, more students are scoring over 1000 on the SAT than in previous years.

Some teachers and administrators feel that the socioeconomic background of students partially explains low test scores. Others, such as the principal, strongly disagree: "My faculty and I sometimes . . . part because I think the socioeconomic factors that many people use for excuses about test scores is crap. You know, I think that if you expect students to do better, they will do better. I think that what has happened, we have not expected enough from students. We have not been holding them accountable for what we expect."

Placement. S2 has a bridge program in math that is intended to prevent a high dropout rate; bridge courses are provided for at-risk students during the transition period between eighth and ninth grade. The bridge course in math allows students to study eighth-grade (BSAP) math content while getting high school math credit. The rationale for the bridge program is that students will get caught up on basic skills in ninth grade and then take Algebra 1 in tenth grade, thereby getting back on track for a college prep diploma.

BSAP, Stanford-8, and district Area Exam scores influence student placement in math. Students with low scores are placed in remedial and general track courses. Students with average to above average scores are placed in college prep. High scoring students go into honors and advanced placement courses. Science placement is related to English and math classes students are taking. Students rarely take college prep science if they are in general track math or English. Teacher and parent recommendations and grade point average in prerequisite classes also influence student placement.

At S2, in order to take Chemistry, a student must first pass Algebra 1 and Biology. The science department wanted to require that students pass Algebra 2 before taking Chemistry, but the district did not approve that change. Currently, students must merely be enrolled in Algebra 2 or higher to take Chemistry.

Teachers expressed concern that the tracking system was not being done "correctly" or "honestly." There is pressure by the administration to push students to take advanced courses, even if the child and the parent do not want it. A science teacher said she believed some students fail intentionally in order to get out of an advanced class.

School Role. Teachers at S2 pay attention to state tests and curriculum guides, since the ability of students to perform well on tests determines additional funding. Both math and science department chairs pay attention to district and state objectives. The science department chair feels that the state and district are trying to bring science into the 21st century and are recognizing the importance of science.

South Carolina - Smaller Rural District

The philosophy of the district level administration is that the principal is the instructional leader of the school; the district can facilitate change, but the catalyst for change is the principal.

At the time of our study, the district was beginning to grapple with the implications of the NCTM *Standards* and the emerging national emphasis on problem solving and application. District administrators were aware that the state education agency was exploring incorporating NCTM-like content into the BSAP exam, but nothing concrete had come of this as yet. District administrators felt that the district had essentially peaked on the state basic skills exam and that further improvement should come in the area of problem solving and application. For this reason they encouraged the state to move ahead with curriculum initiatives of this type.

The district recognized it would need to retrain teachers if the state revised the basic skills exam to incorporate NCTM-like content. They were planning to offer some inservices that emphasized content (e.g., statistics) in addition to process-oriented workshops. This emphasis, they felt, would help prepare teachers for an eventual transition from a memorization and facts-oriented curriculum to a problem-solving critical thinking curriculum. The district curriculum specialist for math said the district was in the process of acquiring more mathematics manipulatives and that these would be introduced and promoted in district workshops.

This sparsely populated rural district lacked the sufficiently large student population needed to achieve certain economies of scale. The district administration was relatively small and thus unable to provide staff support to teachers at a level sometimes seen in larger wealthier districts. Though the district was near the state average for per capita student spending (in part because it did well in competing for SIRP awards), money was spread thin because the district operated a large number of schools relative to the total student population.

The most remote schools in the district had trouble attracting teachers. To remedy shortages, which tended to be worst in high school math and science, the district paid teachers from popular schools bonuses of $4,000 - $5,000 annually to spend a year teaching in one of the remote schools. Strategies such as these enabled the district to resolve some problems but cut into the resources available for other purposes.

Testing. The district administers the BSAP and Stanford-8 exams as required by the state. The new district superintendent firmly supports the testing program and emphasizes the importance of test security.

College-bound students in the district also take the ACT and SAT. A senior district administrator reported that the district had experienced some problems in connection with these exams. At least one high school principal had told a number of low-achieving African American students that they should not take the SAT as required by the colleges to which they had applied. The principal's perspective was that there was no point in the colleges requiring SATs because they never turned students away, no matter how low their test scores. At the same time, the principal felt, having the scores of low-achieving students included in the school's statistics made the school appear ineffective in preparing legitimate college-bound students.

The central administrator said he could empathize with the principal; it was a sham for "those black colleges" to require test scores when in fact they made no use of them for admissions or any other purpose. However, the administrator said it was nevertheless inappropriate for a principal to interfere with students in this way. He said he planned to tell the principal that he had gone too far in his quest for high test scores and that students must be allowed to take standardized exams as requested by colleges.

Textbooks. The district chooses textbooks from a list of state-adopted texts. Teachers at each school select a representative who brings the school's choice to the district textbook adoption committee. Books at the high school level are usually differentiated according to ability level; therefore, the district may adopt as many as three different books for one subject area. Schools then decide whether they will use some or all of the district adopted texts in a given subject.

Guides. The district recently produced new course outlines stating main objectives for all high school courses. These documents are brief and serve only to delineate the scope of courses in general terms. The guides do not specify student objectives at the level of daily lessons and they do not provide suggestions for pedagogy or assessment. District administrators said they would like to have highly specific course guides for high school math and science. However, they noted the district lacks the staff capacity necessary to do that and conduct other important administrative tasks. The assistant superintendent said he hoped and believed the state would produce new helpful course guides in the next year or two. Barring that, he predicted the district would go ahead and invest its own organizational resources in designing some. He further predicted that problem solving and application would play an important role in the conceptualization of any guides the district would create.

Professional Development. The district sets aside five work days for staff development, as required by the state. There are district designated and school designated staff development days.

The assistant superintendent felt the district could have done more staff development than it has done and that the need for staff development will be more critical as the district moves toward its new initiatives (i.e., course guides including problem solving and critical thinking).

According to the district math curriculum specialist, the state requires all districts to choose a staff development model for all teachers. The district uses the PET (Program for Effective Teaching) model, which emphasizes teaching subjects in incremental stages. This model emphasizes pedagogical and classroom management insights derived from effective schools research.

The district spent $200,000 on staff development in 1989. The funding was a combination of local money, Eisenhower funds, and state-allocated money. The Eisenhower funds, which are evenly split between math and science, allow the district to provide the teachers with materials so that they can apply what they have learned through inservice sessions. In addition, the district used Eisenhower funds to send two teachers from each of its 35 schools to the South Carolina Council of Teachers of Mathematics conference. Teachers reported that they found district inservices helpful and interesting.

Evaluation. Districts are required by the state to have an approved teacher evaluation program. S3's district has chosen a Consensus Based Evaluation (CBE) model. CBE calls for teams of three observers to visit a teacher's classroom several times before writing a joint evaluation. The teams also meet with the teacher to discuss the results.

CBE teams must include at least one evaluator with teaching experience in the subject of the teacher being observed. Teachers who serve as CBE evaluators undergo extensive training and regularly take release time from their own classes to travel to schools elsewhere in the district.

Teachers view CBE to be highly labor intensive. Many resent being evaluated by individuals who have no teaching experience in the teacher's field. Individuals have complained that CBE takes time away from instruction. The math curriculum specialist indicated that there was a lot of animosity toward CBE because teachers must receive a superior rating on CBE to qualify for Teacher Incentive Program awards worth up to $2,000.

Placement. Students are placed into remedial programs at grades 4, 5, 7, and 9 on the basis of norm-referenced testing results. Low BSAP scores also trigger remedial referrals. Following state regulation, there is a minimum score students must make on the BSAP math, reading, and writing tests to be promoted in grades 1, 2, 3, 6, and 8. Students must pass the tenth-grade BSAP to receive a diploma. Those who fail any section of the BSAP exit exam on their first attempt are placed in the appropriate remedial courses until they succeed.

South Carolina - Smaller Rural School (S3)

S3 is a small rural school headed by a veteran principal who is deeply involved in the daily operation of the organization. The principal's key concern was to produce high test scores and win state funds. This concern was evidenced in various ways. A large bulletin board facing the door of the main office extolled the virtues of good attendance and homework habits, specifically for success on the BSAP and Stanford-8 exams. The school further underscored the importance of test scores to students by giving students with scores above 70% on the BSAP a free pass to athletic events and other school activities. The funds for this came from the previous year's SIRP awards.

Pursuit of SIRP awards also affected the principal's relationship with teachers. For example, SIRP rules stated that schools posting large gains on test scores would receive reduced SIRP awards if the average daily attendance for teachers or students fell below the 95% level. One year S3 lost money because teacher attendance dipped just under 95%. The following year the principal began making routine phone calls to teachers' homes on days when they called in sick. Teachers believed they would be confronted and face serious disciplinary action if they were caught "playing hookey."

The principal's authority extended to all areas, not just testing policy. For example, the first time we met with the principal to discuss the nature of our project, we began by explaining that teacher participation was voluntary and that teachers would be compensated for their time. He immediately interjected, saying it was up to us whether we would compensate "his" teachers, but all of them would participate. Indeed upon meeting with teachers, it was clear that they understood that they were to follow our instructions without question. The fact that teachers expressed being pleasantly surprised when informed about our intention to pay them reinforced our impression that the principal had exceptional decision making power and authority.

Testing. The principal's impact on math and science instruction in the school was informed by the desire to produce high scores on basic skills tests. Although the principal never mentioned to us that he personally received money for high test scores, he did observe that teachers placed a high value on the TIP bonuses they had received. The simultaneous benefits of high scores for students, administrators, and staff, in combination with the belief that the school was well positioned to compete for awards, may help account for the teachers' reports that they worked in an environment characterized by high levels of collegiality and job satisfaction. The relationship among testing, school level policy, and classroom practice is evident throughout the discussion of S3.

Guides. Teachers at S3 have put together informal curriculum guides. The guides are basic skills-oriented and sometimes based on textbooks no longer in use.

The only courses in the entire school for which there was a highly specific, standard curriculum were the remedial courses for students who failed the BSAP exit exam. The remedial math teacher relied on detailed state teaching manuals and a state approved software package for the computer lab in which remedial instruction was given. The remedial teacher, along with her full-time aide, made sure that every moment in her classes was devoted to learning basic skills objectives from the state exam. No other teacher was more central to the school's strategy for raising the average BSAP score and winning SIRP and TIP awards. The remedial teacher also enjoyed a larger share of the organization's resources than others.

Textbooks. Teachers in intermediate and upper level math and science courses tend to work through their textbooks from beginning to end but skip sections they deem inappropriate or of secondary importance.

Professional Development. Two math teachers indicated that they were participating in district-funded workshops on using calculators, including graphic calculators, and manipulatives.

Evaluation. The principal conducts four walk-through observations and one 30-minute observation per day at S3. The new district superintendent requires that the 30-minute observations be written up and turned in on a weekly basis.

Some teachers resent this intrusion by administrators into their classroom: "I hated for somebody to come in and observe me and tell me I was doing something wrong when they did not even teach the course that I was trying to teach. I mean, can you come in and tell me that I am not doing it correctly if you don't teach the course? . . . They really don't do that, but in a roundabout way, that is the feeling you get."

Resources. At S3, there is one instructional budget for the entire school and each teacher receives $200 to spend on each class. Departments can ask the school administration for additional materials, and they will be provided if there are sufficient funds.

The district provides the Computer Curriculum Corporation (CCC) program to schools to be used in remedial math classes. The CCC program is in every high school and middle school in the district. Remedial students must spend at least ten minutes a day doing the CCC drills. From inservices, the remedial math teacher we interviewed has learned that other remedial teachers in the district who did not voluntarily agree to teach the remedial program complain about the required computer time. "You know, because they find it hard, they're used to doing instruction . . . and the movement drives them crazy."

In 1987 and 1988, the school won SIRP and TIP awards. Much of the SIRP money was used to purchase computers for remedial instruction. Under state rules, any school that receives a SIRP award in one year is "deregulated," or exempted from many EIA-related policies for the two following years. This exemption gives schools greater control over things such as scheduling and teacher assignments. S3 was not taking advantage of its deregulated status in 1989-90 because the administration did not know whether it would remain deregulated during 1990-91. For example, the school could conceivably use deregulation in 1989-90 to hire teachers who lack math or science certification to teach math and science classes only to find the following year that those same teachers are no longer eligible to teach such courses. These changes could pose major difficulties for a small school such as S3 in which the small staff size limits organizational flexibility.

Students. S3 is in a low SES area. About 25% of the students are in the free lunch program. At S3, the dropout rate is roughly three percent per year. This is very low for South Carolina. The school enrolled about 900 students in 1989-90. About 70% of the students were African American, the other 30% were white.

Students performed well on the BSAP and Stanford-8 in 1987 and 1988. In 1989 test scores dipped. The 1990 graduating class was the first to come under the exit exam and 95% of the students passed. School personnel estimated that 20%-35% of all graduates continue to college.

Placement. Parents can override a counselor's or teacher's recommendation and have final say about whether their child will be placed in remedial, general, or college prep classes. Teachers have little say in student placement. Many complained that it was common for students to begin the year in courses for which they were not well prepared. According to the counselor, about 15% of students are in the wrong track in math and/or science at the beginning of the year. She attributes this to the district's policy of respecting parents' preferences when it comes to the courses their children take. Later in the year, when it becomes apparent which students are failing courses, as many as five to ten percent of those believed by counselors or teachers to have been misplaced at the start are moved into lower level courses.

School Role. Teachers of lower level math courses at S3 closely follow the content covered on the BSAP test. The remedial math teacher decided what she was going to teach by consulting the records of all her students on BSAP performance. Teachers in upper level courses, such as Algebra II, operated entirely outside the realm of basic skills and therefore were little affected by state curriculum policy.

EIA funds, such as SIRP awards, have major impact on the school's resources and on a teacher's or administrator's earnings in a given year. The principal devotes much of his time and energy to supporting and, when necessary, compelling teachers to contribute all that they can to producing high test scores. The principal reports that he and his staff "had gotten a little lazy" in the years preceding the EIA; he thought the incentives had a very positive impact on staff morale and student achievement at S3. He intended to do whatever he could to continue to enjoy EIA benefits for as long as they were available.

Conclusions

From the state-by-state, district-by-district, and school-by-school descriptions of curriculum upgrading in mathematics and science, some patterns emerge. First, cross-cutting analyses are provided of state initiatives. These are followed by analyses of district and school responses.

Increasing High School Graduation Requirements

Increases in math and science graduation requirements occurred in each of the six states during the period from 1987 to 1989. Of the six states, only Florida and Pennsylvania set their requirements at the level recommended by A Nation At Risk (i.e., three credits of mathematics and three credits of science). The largest increase was in Florida, three credits in each subject. According to Meyer (1990), only three states have a requirement of three science credits (they also require three credits of math), and only ten states have a requirement of three mathematics credits.

Florida provides financial incentives to schools that certify that their lab science courses include 40 percent lab work. In South Carolina, the science requirement must be lab science, but only 20 percent of a lab course must be spent in lab work. South Carolina allows one of the math credits to be satisfied with computer science. Florida, South Carolina, and Missouri have an academic diploma, as distinguished from a regular diploma. For example, Florida's academic diploma requires four years of mathematics (to include algebra, geometry, and trigonometry) and four years of science.

In each state, universities have entrance requirements that frequently exceed the state high school graduation requirements. Arizona universities require three credits of mathematics and three credits of science, including two credits in lab science. California universities require three credits of mathematics and two credits of science, including one credit in lab science. Missouri university requirements match state graduation requirements in quantity, but the two math credits must be algebra or higher, and both of the two science credits must include lab work. Similarly in South Carolina and Florida, the state universities match the state high school graduation requirements in quantity, but stipulate that the three mathematics credits must be algebra or higher and that one or two of the science credits (depending upon the university) be in a lab science.

In addition to credit requirements for graduation, two of the six states require exit exams of one form or another. In Florida, students must pass a minimum competency exam in language and mathematics, but not science. Similarly, South Carolina has a tenth-grade exam that covers reading, writing, and mathematics, but not science. In both states the focus of these exams is on basic skills and minimum competencies, and the exams must be passed in order to graduate.

Curriculum Frameworks

Of our six states, two use curriculum frameworks as their lead policy instrument in efforts to influence and support the quality of instruction in schools. California 1985 frameworks are the best known of all state frameworks. Now, California is revising its mathematics framework to bring it more completely in alignment with the NCTM *Standards*. California's 1985 science curriculum framework was revised in 1990, about the same time as our study. Just as the California mathematics framework has been influenced by the NCTM *Standards*, similarly California's science curriculum framework has been influenced by the Science for All Americans report.

California's approach to curriculum frameworks makes more use of leadership and persuasion than prescription and requirements. These frameworks focus more on a rationale for curriculum reform and "big ideas" than on the specification of particular mathematics or science topics that should be taught. The science framework has 40 major ideas, and the mathematics framework has 7 "strands." In both mathematics and science, the California frameworks reflect the 1989 curriculum reform toward an emphasis on higher order thinking and problem solving and away from an emphasis upon facts and low level skills. None of these topics is "required," though they are advised.

Arizona also uses curriculum frameworks as a lead policy instrument, though its framework is called "essential skills." Initiated in 1972, mathematics essential skills were revised in 1988; science essential skills were being revised at the time of our study and based on the Science for All Americans report. Both Arizona revised frameworks reflect a focus on higher order thinking and problem solving. Nevertheless, the revisions were too close to the time of our study to have had any noticeable influence on classroom data.

Our other two states that provided curriculum leadership, South Carolina and Florida, both had curriculum frameworks that focused on basic skills. The South Carolina framework, Teaching and Testing our Basic Skills Objectives (1982), presents objectives and related activities at the course level. The science basic skills were revised in 1985 to specify 20 percent lab time. Florida has Student Performance Standards of Excellence for Florida Schools (1984), stating expected learner outcomes for grades 3, 5, 8, and 12 in both math and science. Florida also has a curriculum framework for grades 9 through 12 that lists courses with 20 to 40 objectives per course. These curriculum frameworks are clearly not the lead policy instrument in either state; tests are. Both focus on basic skills; however at the time of our study, both states were considering revising their curriculum focus to reflect the 1989 curriculum reform.

Missouri has Core Competencies and Key Skills (1985, reprinted 1990), which cover math and science objectives for fourth through tenth grades. However, the state does little to promote these competencies that (at the time of our study) predated the 1989 curriculum reform. Pennsylvania had no curriculum framework at all, though they did have A Recommended Science Competency Continuum (1987, reprinted 1991) and a set of Mathematics Content Lists (1987) that provided suggestions for math and science curricula. At the time of this writing, Pennsylvania had begun to move toward an outcome-based curricular strategy aligned toward NCTM *Standards*, but was still in the process of determining the level of specificity at which frameworks (and outcomes) would be aimed.

State Testing

Although testing is the lead curriculum control policy instrument in South Carolina and Florida, testing is much more frequent in the early grades than it is in high school. Both states test only in tenth grade at the high school level and only in reading, writing, and mathematics. Both states' testing programs are aligned to their frameworks that focus on basic skills and minimum competencies. Florida began its testing program in 1986, and South Carolina began its testing program in 1985.

Both states take measures to give power to their testing programs. In Florida, students who fail state tests in any of the grades tested (3, 5, 8, and 10) must be provided remedial instruction. In South Carolina, there is a School Incentive Reward Program (begun in 1985) that gives cash awards to schools based on gains made in student achievement scores. A Teacher Incentive Program gave cash awards to teachers, again based on gains in student achievement. Initiated in 1985-86 as a pilot program, the South Carolina teacher incentive program was statewide in 1989-90; one in four teachers received an average award of $1,700.[1] However, in 1990-91, the state appropriated no funds for the program. Finally, in both South Carolina and Florida, students are required to pass the tenth-grade test in order to graduate from high school. In Florida, students can take the test as many times as they wish, while South Carolina students are limited to five tries.

In the two states whose curriculum goals reflected the 1989 curriculum reform, testing programs were being revised. Arizona was in the process of replacing its twelfth-grade test (TAP) and its ITBS testing in grades 2 through 12 with a new Arizona State Assessment Program (ASAP). The TAP and ITBS tests are not well aligned to state essential skills; however, the new ASAP will reflect the state essential skills, including higher order thinking and problem solving. ASAP will be given in grades 3, 8, and 12; begin in 1992-93; involve performance assessment; and include mathematics and science. Similarly, the California Assessment Program (CAP) was being revised to emphasize performance assessment and alignment with the state frameworks. At the time of our study, testing was done in grades 3, 6, 8, and 12 in mathematics but not science. Testing was done on a matrix sampling basis for students but reported at the school level, with high performing schools receiving noncash recognition awards. In 1991-92 California suspended its testing program.

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[1] For both the continuing School Incentive Reward Program and the discontinued Teacher Incentive Program, student gains were determined by first placing schools in quintiles according to student socioeconomic status and teachers' years of education, and then within each quintile deviating actual gains from predicted gains.

Both Missouri and Pennsylvania had basic skills oriented testing programs. Missouri's testing (MMAT) began in 1985. Districts are required to test students four times between grades 2 and 10, but they are not required to report the results. The MMAT is aligned to the state "core competencies" and "key skills." Both mathematics and science are tested. In Pennsylvania, the TELLS tests basic skills in reading and mathematics each year in grades 3, 5, and 8. There is no science testing and no testing at the high school level. Since our study, the Pennsylvania testing program has been renamed PSAP and is to be expanded to include grade 11. It will be administered each year to one-third of the schools in the state.[2] At least at the time of our study, the focus of state testing was to remain on basic skills and minimum competencies.

Several things are apparent from these state approaches to testing. First, testing is a much more common policy instrument at the elementary school level than at the high school level. Testing is also much more prevalent in mathematics than in science. While testing is the lead policy instrument in states with an emphasis on basic skills, it was not at the time of our study the lead policy instrument for either of the states emphasizing a curriculum oriented toward higher order thinking and problem solving. At the time of our study, states with a curriculum reform agenda had testing programs that were not aligned with that agenda. Efforts were underway to revise or replace old basic skills testing programs with testing programs aligned to the new state curriculum frameworks.

While all six states used testing as a policy instrument, four did little to add power to their testing programs. California gave weak incentives to high performing schools. Arizona and Pennsylvania reported results by school but did nothing else. Missouri did not even receive the results. In sharp contrast, California and Florida gave considerable power to their testing programs. Even state testing programs with no rewards or sanctions attached to them can be influential, however, depending upon how they are used at the district and school level.

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[2] Rotated, so that once every three years each school will be tested.

Other State Standard Setting and Curriculum Upgrading Initiatives

Somewhat surprisingly, neither of the two states aggressively adopting the 1989 curriculum reforms had a well-funded and coherent program of staff development to support the desired (substantial) changes in teacher practices. Like all states at the time of our study, Arizona and California received federal Eisenhower Mathematics and Science Education Program funds, approximately two-thirds of which were to be passed on to districts for staff development. But neither state targeted these flow-through funds in ways that might give them more leverage to accomplish state curriculum reforms. California did, however, ask for district plans and required that the funds be used in ways consistent with state frameworks.[3] Generally, these Eisenhower funds are spent on short-term training efforts for teachers who volunteer (Knapp, Zucker, Adelman, & St. John, 1991).

One important exception to the nonprogrammatic and limited nature of state staff development efforts was California's Math A program. Math A is a teacher designed (but state promoted) course for students who might otherwise have taken ninth-grade general mathematics. The intention is to give these students mathematics consistent with the state framework that might potentially bridge them into more advanced courses in subsequent years. The state provides a required five-day summer inservice for all new Math A teachers. Several local sites have extended the state's staff development requirement by increasing the summer program to four weeks and adding inservices during the academic year.

The only state having a significant investment in staff development was Florida, which spent approximately $10 million during the year of our study to support 60-hour summer institutes focused on mathematics and science. The program was a legislative initiative to deal with the demand for more certified math and science teachers as a result of the increased graduation requirements in math and science. The summer institutes were also used to keep teachers up to date on math and science related issues. While the state provided the funds, decisions regarding the structure and content of the institutes were left to local discretion.

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[3] In 1988-89, the Eisenhower program was $124 million nationally, which translated into an average of $30 per teacher (approximately $1.5 million in Arizona and $13.5 million in California).

State textbook adoption was a relatively unused and weak curriculum guidance strategy in our six states. Pennsylvania and Missouri had no textbook adoption policies. Arizona and California had adoptions, but only for grades K through 8. South Carolina and Florida did have textbook adoptions that affect high schools. For example, Florida adopts three to five texts per subject on a four-year cycle. But neither of these states used their adoption policies as leverage over publishers. Since adoption lists in both states include options, and since textbooks are not prescriptive of classroom practice, the potential of state textbook adoption for influence on instruction was limited.

From this description of state curriculum policies, several conclusions can be reached. First, in 1989-90 and 1990-91, state approaches to curriculum upgrading were piecemeal; not all of the pieces fit together in consistent ways. In particular, states attempting to reform curricula consistent with recommendations of professional societies had tests inconsistent with their curricular goals. Second, the time of the study was a period of transition; four of the six states were attempting to move away from basic skills and toward higher order thinking and problem solving. California was furthest ahead with Arizona next. Florida and South Carolina were just in the process of rethinking their substantial curriculum control strategies designed to ensure basic skills. If they take up the curriculum reform agenda, they will have considerable work ahead of them both in undoing past initiatives as well as putting in place new initiatives. Pennsylvania and Missouri seemed content to continue playing a minimal role in curriculum leadership, delegating those responsibilities instead to districts and schools.

Smith and O'Day (1991) have called for systemic school reform. The approach is to start with clear and challenging standards for student learning. Policy initiatives are to be tied to these standards for student learning and are to be consistent with each other, so that there is coherent instructional guidance to schools and teachers. Within this environment of clear goals and consistent policies, schools are to be given flexibility to develop strategies as needed. In our six states we found no evidence of systemic school reform directed toward the 1989 goal of ambitious content for all students. Both California and Arizona appear to be moving in that direction, with California in the lead. The California frameworks are an excellent starting point for systemic reform toward ambitious content for all students. California tests, however, are still in the process of being revised. California does not coordinate its staff development efforts with its curriculum guides and generally has an insufficient staff development program to support the kind of teacher change envisioned by its frameworks. Similarly, Arizona is moving to revise its testing program, but at the time our of our study state tests stood in sharp contrast to what state essential skills sought to promote.

Materials consistent with the curriculum reform were lacking. School days and school years were structured in ways that gave teachers relatively little time for planning instruction and relatively little time for providing students with feedback on their work. Unless districts and schools make major investments to make up for these lacking resources, it seems unlikely that the magnitude of curriculum shift hoped for will occur.

The lack of good examples of systemic reform to promote the ambitious content for all students curriculum reform may be explained by timing. The curriculum reform was too new for states and districts to have responded with policy initiatives. It may be, however, that a systemic and coherent set of policy initiatives that seek to guarantee minimum basic skills is easier to conceptualize and implement than a systemic and coherent approach designed to promote excellence (Porter, 1989).

The best examples we found of systemic reform were in the Florida and South Carolina urban districts. In each case, the learning goals for students were clear, but clearly focused on the basic skills of the 1960s and 1970s, not the higher order thinking and problem solving of 1989. State tests were consistent with state frameworks; district tests at the course level were aligned with district course level curriculum guides, which in turn were aligned to state frameworks. Florida had a large and impressive investment in staff development, with 60-hour summer institutes taught on mathematics and science and funded at a $10 million annual level.

Reactions to State Initiatives

Districts, schools, and teachers have different understandings of what is intended by state initiatives. They also vary in the extent to which they believe state initiatives should or must influence their practices. The general tendency is thus toward uniqueness of response, not standardization of practice. There were, however, some important general tendencies.

District Responses

State initiatives in curriculum upgrading and standard setting tend to stimulate additional initiatives by districts. Even state initiatives with little power and modest prescriptiveness receive some attention by districts. Often districts go well beyond what is required, adding to state initiatives their own extensions and enhancements.

State and district curriculum frameworks are a good example of this point. The urban district in Arizona used state essential skills as the basis for developing curriculum guides in each subject area; the district subject guides were far more detailed and elaborate than the state skills. In California, both the urban and rural districts developed curriculum guides based on state frameworks. The urban district went even further, adding Math A as a new offering consistent with the state mathematics framework, and revising science guides to reflect the integration across science disciplines found in the state framework. Even in Missouri, with a briefly defined set of core competencies and key skills and no consequences for compliance, both the urban and the rural districts had developed their own curriculum guides to reflect and elaborate upon the state's. South Carolina and Florida urban districts are even better examples of districts taking state curriculum guides with relatively little information and expanding them into detailed and prescriptive documents including student objectives and teacher activities.

Districts also used state tests in ways that went well beyond anything suggested by the state. The Florida urban district used the state test to evaluate schools. The Missouri rural district used the state test at every grade level, from grade 2 to 10, despite the state requiring testing at only four grade levels. In the Missouri urban district, the state test was used as an indicator of school success; principals believed that their jobs were on the line if student performance did not go up. The state of Missouri, however, did not even require that the results of its test be reported.

In Florida and South Carolina, with their test requirements for high school graduation, both urban and rural districts developed remedial courses so that students who initially fail can receive the preparation necessary to ultimately pass.

Generally, the more curriculum upgrading and standard setting activities at the state level, the more additional curriculum upgrading and standard setting activities at the district level. California and South Carolina districts had the most comprehensive sets of district initiatives, while district initiatives in Missouri and Pennsylvania were fewest in number and strength. Florida and Arizona districts fell between these two extremes. At least in curriculum matters, districts appear less inclined to step in to fill voids left by their state than they are inclined to be stimulated into action by state leadership.

Large urban districts are more active in standard setting and curriculum upgrading than small suburban and rural districts. The South Carolina urban district had, in addition to the state test in grades 1, 2, 3, 6, 8, and 10, Stanford achievement testing in every grade and district-developed final exams required districtwide in Algebra 1 and General Math. Similar district-required final exams were planned for Physical Science. The district had its own detailed curriculum guide for each subject. In contrast, the South Carolina rural district had a policy of principal leadership. Required state testing was done, but district initiated testing was modest and being reduced. In Arizona, the urban district developed its own criterion-referenced tests for 23 math courses and 9 science courses; these exams could be used as the basis for 20 percent of a course grade. The district was attempting to eliminate tracking and had already targeted ninth-grade general math for elimination. A districtwide effective schools initiative required school improvement teams at each school. District curriculum guides went well beyond state essential skills. In contrast, the rural district in Arizona used high school personnel to serve in dual roles as district personnel; for example, high school math and science department chairs served as district curriculum specialists. That rural district had no special initiatives of its own in the areas of frameworks, testing, or staff development.

There are several possible explanations for why urban districts are more active in curriculum upgrading and standard setting than rural districts. First, the urban districts have larger bureaucracies for implementing state initiatives and for adding to state initiatives in ways unique to the district. Second, generally speaking urban district personnel are more convinced that change is necessary; they are more highly motivated toward change than are rural district personnel. Third, there appears to be a much greater commitment to classroom level control in urban districts than in rural districts. This may in turn be explained by weaker connections between school and community in urban settings.

School Responses

The most substantial standard setting and curriculum upgrading initiative we encountered occurred at the school level, remedial courses replaced by the requirement that all freshmen take college prep coursework. Slightly less dramatic but still substantial were school efforts to counsel students into the college prep track in greater numbers than had historically been done.

The impetus for these school efforts to increase enrollments in challenging academic content cannot be found in any straightforward sense in state initiatives. State increases in credit requirements for high school graduation did not specify that credits be in demanding academic content, though college admissions requirements often did. As was noted, the Arizona urban district was working to eliminate general mathematics, but one high school in the district had gone well beyond the district's vague initiative; and was requiring all general math and general science classes to be eliminated and all freshmen to take algebra and chem/physics. The school hopes this will eventually lead to increased enrollment in upper division mathematics and science classes. Another high school in the same district had taken a softer approach, eliminating many, but not all, sections of lower level science and mathematics courses, while adding an advanced placement curriculum. A summer school program was instituted to assist students in advancing more quickly through the curriculum so that they could take higher level courses. In the suburban Pennsylvania district, basic science and mathematics courses were eliminated. In one school, all students were required to take basic algebra followed by basic geometry. Implementation had not been easy; a new "Math 9A" course was developed to serve remedial students and honors algebra was made available for advanced students. Still, of the eight freshman math classes, six were basic algebra, with only one Math 9A and one honors algebra.

Another school level response in urban districts was magnet schools. The motivation for these magnet schools was primarily desegregation. In the Arizona and Missouri urban districts, large amounts of desegregation funds supported the magnet school initiatives. In the Pennsylvania urban district, a science magnet at one school had the unfortunate effect of attracting able students in mathematics and science away from other schools. As a result, honors programs in the nonmagnet schools had been eliminated. Teachers reported that students in their schools no longer had the background to complete advanced coursework in science and math. This complaint was echoed by teachers and administrators in the Missouri urban district, primarily due to the "siphoning off" effect of magnets.

Even among schools in districts with substantial curriculum control, we found many instances of important differences among schools. In the Florida urban district, one high school used site-based management as a high profile issue, with teachers organized into a body politic that voted on a variety of issues related to the school. School esprit de corps was a high priority for the administration. Students and teachers were continually reminded that the school put a premium on academic excellence. In that same high control state and district, another school was characterized by antagonisms among and between administrators, teachers, and students. The origin of this antagonism appeared to lie with the creation of two teacher cadres and two administrative units through forming a "school within a school." In the South Carolina urban district, the two high schools differed substantially in the extent to which students were pushed toward more demanding curricula. In one school, teachers were committed to their discipline in a way that led them to favor ability groups and the exclusion of at-risk students from advanced courses. Another school was committed to doing its best to get as many students as possible into college prep courses. School personnel here proclaimed a commitment to providing the type of nurturing that accommodates different ability levels while challenging all students to try harder.

Many urban and rural schools that serve high concentrations of low achieving students are extremely poor. This lack of money makes it difficult for them to accommodate state and district initiatives. State and university requirements for increased offerings in science, and particularly lab science, had resulted in insufficient lab space and inadequate numbers of qualified teachers. The 1989 curriculum reform emphasis on active learning and real world applications left teachers struggling to find the funds to purchase manipulatives and to take students on field trips. In the Pennsylvania and Florida urban schools, even such basic supplies as textbooks were a problem. Important exceptions to this rule of insufficient instructional resources were schools receiving large amounts of desegregation money. One of the high schools in the Arizona urban district received approximately $2 million per year in additional funds from a court ordered special property tax levied to support a desegregation order. Similarly, in the Missouri urban district, each department received substantial funds each year for instructional improvements; these state funds were provided in compliance with the desegregation order. Unlike the Arizona urban high school, which expects to receive its property tax funds indefinitely, the Missouri desegregation monies will be discontinued in 1992.

Despite the many differences we found among schools, we found little evidence to attribute these differences to principal leadership. The differences in our two Arizona urban schools were primarily a function of a desegregation order, though the principals were effective in both those schools. The differences in our two Florida urban schools and our two South Carolina urban schools are difficult to explain. They appear to reflect basic differences in school culture, differences that had been in place for some time. Teachers and administrators interviewed weren't particularly aware of these cultural differences; they certainly did not attribute them to a particular individual. In the Missouri district, principals felt under the gun to raise test score results, but this pressure tended to make our two Missouri urban high schools more similar through principal initiatives than it tended to make them different.

Chapter 4

STATE AND DISTRICT POLICY CONTEXT AND SCHOOL RESPONSE: A SOUTH CAROLINA CASE STUDY

In South Carolina the state legislature, governor, and state education agency launched an aggressive reform program with the Education Improvement Act (EIA) of 1984. South Carolina initiatives were designed to impact math and science, and they reflect educational goals and reform strategies emphasized nationally in the post-*Nation At Risk* (1983) period. In particular, South Carolina reforms, for the period 1984-1990, targeted basic skills achievement and increased standards for promotion and graduation. South Carolina's reform strategy was also of special interest because it was designed to affect many actors simultaneously, including students, teachers, and administrators at all levels. The reforms also require the support of taxpayers and industry. Because the South Carolina reform program contained all these facets, it raises many questions of importance to policymakers.

This chapter synthesizes data from (1) multiple visits to sites; (2) interviews with teachers and with school, district, and state administrators; (3) teacher questionnaires; (4) teacher observations; (5) teacher logs; and (6) official school, district, and state documents. Our aim is to describe the evolution of policies as state policies are refracted through districts, as district and state policies are mediated by school administrators, and as teachers fashion their own understanding of policies--ultimately determining whether and in what way policies affect their work in the classroom.[1] What is the process through which formal policies are conveyed to and interpreted by those who enact them, and how do these policies reinforce or change existing classroom practice?

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[1] Although much of these data are qualitative, we make no claim that our methodology is ethnographic. An ethnographic study would require comprehensive inquiry into the participants' general perspectives on teaching and education. After that inquiry, one would then fit into their general system of beliefs their views on the specific policies of interest. We were limited to one or two observations per teacher, and our interviews directly addressed the participants' views on particular policies. Thus our inquiry focused on specific perceptions and experience and did not explore views on education generally. Interview excerpts included in this chapter have been edited to remove excessive backchanneling and repetition by speakers.

Like any analytic concept, the policy implementation process is not subject to direct observation. We can, however, determine how particular actors understand a policy at given points in time. Thus, we look first at the political and professional interests and discourse that shape a policy at the state level and at the original intent of a policy as it was understood by those who designed it. Next, we see how district administrators use their own power to reinforce, extend, or ignore state policy. Finally, we look at how teachers experience a policy and the extent to which it informs their decisions about curricular content and method.

Part I of the chapter discusses state policies affecting secondary math and science. We describe the nature and intent of important state initiatives, many of which originated with the EIA in 1984. We indicate where EIA policies represented a departure from those in force before 1984 and assess the overall consistency of state policies.

Part II focuses on how two South Carolina districts studied by Reform Up Close respond to state policies. We distinguish among district policies that wholly embraced state policies, those that attempted to modify or deflect a state policy, and others that were intended to exert an independent effect on math and science programs.

Parts III, IV, and V consist of case studies of the three schools studied in South Carolina. The first two schools are in District A, the urban district, and the third is in District B, which is largely rural. The case studies explore the perceptions of school administrators and teachers regarding policy intent, implementation, and effects.

Part I: State Policies Affecting Math and Science

Far from an exercise in statehouse rhetoric, the 1984 EIA identified particular areas for intervention and specific policies to bring about desired changes. The provisions of the EIA affected the everyday lives of students and teachers as well as the administration of schools and the pocketbooks of taxpayers.

The ultimate objective of the EIA was to improve academic achievement. In the view of the state legislature and state education agency, improvement meant raising standardized test scores. Toward this end policymakers addressed several aspects of the educational system that they believed to have been undermining academic achievement for years. Among the factors identified as impediments to achievement were low standards for high school graduation, college admission, and student promotion; ineffective teachers and local administrators, many of whom lacked motivation to improve; and a public that was resigned to inferior, poorly funded schools. Although many states detected similar problems in their own educational systems in the early 1980s, South Carolina moved decisively to formulate a comprehensive set of policies to ameliorate these problems.

Education Improvement Act

Our discussion of South Carolina begins with examination of three particular programs that form the heart of EIA: the Basic Skills Assessment Program (BSAP), the School Incentive Reward Program (SIRP), and the Teacher Incentive Program (TIP). Here we examine the specific provisions, underlying rationale, and intended effects of these programs, concentrating especially on secondary math and science.

The Basic Skills Assessment Program

The Basic Skills Assessment Program (BSAP) is the cornerstone of South Carolina's reform strategy. Students are tested in grades 1, 2, 3, 6, 8, and 10 in the areas of math, reading, and writing on a state-developed criterion-referenced basic skills exam; in grades 1, 2, 3, 6, and 8 students are also tested in science. The exclusion of science on the tenth-grade BSAP is important to understanding why EIA has less impact on secondary science than secondary math. Because BSAP scores are used to administer other EIA programs, excluding science from the high school exam also means the EIA may have less direct bearing on science than math teachers.

The state requires schools to remediate students who score below 80% on any content area of the exam. Although schools rely primarily on special classes for BSAP remediation, all regular classroom teachers must provide some remedial instruction to students on BSAP objectives they fail. Teachers must submit quarterly reports documenting remediation to their principals who, in turn, must summarize this information for the state.

The tenth-grade BSAP test serves as a high school exit exam. Students who complete a regular program of studies without passing the BSAP exam receive a "Certificate of Completion" instead of a regular high school diploma.

BSAP was inspired by the widespread perception that South Carolina's schools were failing. Critics charged schools with engaging in "social promotion" and ignoring the needs of low-achieving students. Subsequently, they argued, schools failed to equip students with skills needed to earn a living and hampered the state's economy by perpetuating a chronic shortage of skilled labor. The entire BSAP program, with the exit exam as its crowning feature, thus came to represent the state's attempt to guarantee that high school graduates possess specific knowledge and skills.

EIA's emphasis on basic skills is reflected in the content of the BSAP exam. The math portion of the tenth-grade exam, for example, is divided into five areas: (1) application of numerical concepts, (2) computation, (3) application of measurement concepts, (4) application of geometric concepts, and (5) mathematical problem solving.

The term application is used here to mean recognizing a fundamental mathematical concept and using it to perform a simple operation or sequence of operations. Two objectives tested by BSAP under the heading "application of numerical concepts" are (1) Determine MPG when given miles and gallons and (2) Use place value to round decimal number to the nearest ten (South Carolina Department of Education, 1985). Although the first objective may involve a greater number of operations or more intricate computations, both require students to determine what mathematical concept is appropriate to the task.

In contrast to the application sections of the exam, the computation portion requires students to solve addition, subtraction, multiplication, and division problems of varying complexity (e.g., add three mixed numbers, with grouping and reducing; find percent of a whole number; subtract two signed integers, with regrouping). Computation items tell students what mathematical operations to perform.

The last part of the BSAP math test is devoted to problem solving. These items are more complex than computation and application items, as seen in the sample items below taken from the problem-solving section of the state BSAP teacher's manual.

> The 11th grade is having a field trip. The class has 232 students participating. All the students are riding by bus. A bus can carry no more than 45 students. What is the smallest number of buses that they will need to carry the entire group?
>
> (A) 4
>
> (B) 5
>
> (C) 6
>
> (D) 7

Read the following information:

– Ann buys ice cream bars wholesale at $3.25 for a carton of 25.

– She sells the bars for 25 cents apiece.

– On the average she works 15 hours each week

To find out how much Ann makes an hour, you also need to be given:

(A) How many hours she works in a day

(B) How much she pays for one ice cream bar

(C) The number of bars she sells in a week

(D) The number of days she works each week

(South Carolina Department of Education, 1985, pp. PS-9.2.1 and PS-9.2.2)

These items illustrate the most complex problem type contained in the mathematics portion of the high school BSAP exam.

Looking closely at the tenth-grade math subtest, we see that the problem-solving section defines the upper limits of mathematical knowledge considered necessary by the state for high school graduation. Nevertheless, BSAP problem-solving items are relatively rudimentary and resemble problems students encounter in even the most basic of high school mathematics courses, if not middle school.

A state department of education official reported that students score lowest on the problem-solving portions of the tests. A review of all BSAP subtest scores revealed that students are most likely to fail the problem-solving portion of the eighth-grade science subtest. Only 45% of the 45,003 eighth graders who took the BSAP science subtest in 1990 passed the section on "science concepts" (South Carolina Department of Education, 1991).

It is not the purpose of this study to determine the precise nature of the difficulties students encounter on BSAP problem-solving items. However, a brief discussion of the nature of these items will facilitate an understanding of other issues addressed later. Poor student performance on BSAP problem-solving items may be attributed to the complexity of the problems rather than to the level of difficulty of the distinct operations included in the items. Problem-solving items are complex because they require students to perform a series of operations and because they do not explicitly state the nature and order of operations students must use. Yet, the individual operations performed in the problem-solving items are the very same ones students complete successfully elsewhere on the test. Relatively high levels of student success at computing solutions to isolated equations and algorithms indicate that the operations per se are not the source of difficulty. Rather, students have difficulty recognizing when knowledge they possess is relevant to the particular problem before them.

Although "problem-solving" items are more challenging than computation and application items, the examples given above show that the level of mathematical knowledge needed to pass the test is modest. In fact, test items are designed to reflect material students are expected to master by the end of grade 8. For this reason, the state's decision to describe their exit exam as a "Basic Skills" exam seems entirely appropriate. Indeed, the main objective of South Carolina's state education policy under EIA has been basic skills intensification, an attempt to increase the efficiency with which schools convey the kind of knowledge for which they have traditionally been responsible.

In Spring 1990, the state began development of a new test: BSAP II. Testing specialists said BSAP II, if carried to completion, would include more Higher Order Thinking Skills (HOTS) items and an emphasis on conceptual understanding as was then being promoted by groups such as NCTM.

In Summer 1990, the state held a Curriculum Congress. The Congress initiated work on a new statewide curriculum by setting up committees of teachers and curriculum specialists to design a curriculum guide for each course on the state's list of approved courses. According to testing specialists, decisions about the content of BSAP II are to be postponed until test designers have seen the new curriculum guides.

Although development is in the early stages, there is a general sense that the new state guides will reflect increased emphasis on HOTS and conceptual understanding. To this end, test designers are exploring different "performance testing" models. Yet testing specialists are emphatic that the new BSAP will involve HOTS and performance testing only if that approach is appropriate to evaluating the curricula adopted by the Congress and its subject area committees. There is no desire, test developers say, to use a new state test to "drive the curriculum" towards HOTS, but only to measure performance on whatever kind of curriculum is eventually implemented.

The School Improvement Reward Program

South Carolina's reform strategy would not have been unique had it been limited to BSAP. Florida, another state in the Reform Up Close sample, also uses "high stakes" testing--tests that determine student eligibility for promotion or high school graduation--to make concrete the commitment to basic skills and to pressure students to improve achievement test scores.[2] South Carolina's strategy is unique because it goes well beyond BSAP and the escalation of minimum standards for students. EIA creates several other programs, each of which incorporates BSAP and introduces additional sanctions and incentives affecting other school actors--including teachers and administrators.

One EIA program designed to make BSAP consequential to teachers and administrators as well as students is the "School Incentive Reward Program" (SIRP). Each year since 1985 the state has used SIRP to give cash awards to schools based primarily on achievement test scores. In designing SIRP, the state realized that the program would improve achievement test scores statewide only if a sufficiently large number of schools could be enticed into competing for SIRP awards. At the same time, policymakers realized that not all schools were similarly situated to compete, so certain provisions were included in SIRP to level the playing field.

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[2] Other states in our sample, including Pennsylvania, Arizona, and Missouri, have state level achievement tests with a basic skills emphasis. However, only South Carolina and Florida base high school graduation upon test performance.

The state first stipulated that SIRP awards would be based on improvement in achievement test scores and not on absolute scores. Even schools with traditionally low test scores might believe they have a chance to win SIRP and therefore enter into competition with traditionally high-scoring schools. The state also anticipated that schools serving low-income students would be reluctant to enter into competition with schools attended by wealthy students. So schools compete in five groups, or quintiles, operating under roughly similar conditions.

The primary factor in grouping schools for SIRP competition is the socioeconomic status of the student population. Lacking a direct measure of family income, the state uses the percentage of students receiving free and reduced lunch as a proxy measure. To the extent that the relationship between a student's decision to apply for free lunch is independent of other factors (e.g., ethnicity, or whether one lives in an urban or rural area), this mechanism provides a convenient way to distinguish between relatively wealthy and poor student populations (Meyer, 1992).

Another factor for which the state controls is the percentage of students "meeting or exceeding the readiness standard on the Cognitive Skills Assessment Battery" (South Carolina Department of Education, 1989, p. 1). However, since this test is not administered beyond the third grade, it affects only how elementary schools are grouped for SIRP competition. No similar mechanism is used to control for the achievement level of incoming students at the high school level. Presumably such controls would be inconsequential because income and achievement are highly correlated and because the state is rewarding achievement gains as opposed to absolute achievement.

In addition to socioeconomic status and readiness, the state attempts to control for the educational level of teachers. Educational level is defined as the average number of years of education teachers have acquired beyond the bachelor's degree. Because the state assumes that more educated teachers have an advantage in producing achievement gains, SIRP groupings are tempered accordingly. As noted above, the proportion of students in the school on free and reduced lunch is by far the most heavily weighted factor in adjusting the groupings for SIRP competition. Meyer discusses the precise formula (1992).

Once the state has schools grouped for SIRP competition, it uses a mechanism called the "School Gain Index" (SGI) to determine which schools within each quintile will actually receive cash awards in a given year. Calculating SGIs for every school in the state requires the department of education to process volumes of test score data using sophisticated statistical techniques.

(1) Each fall the state uses regression techniques and statewide achievement data from the previous year's testing to generate a predicted annual achievement gain for each student in every school.

(2) Then, each spring, after the annual round of standardized testing (tenth graders take BSAP, ninth and eleventh graders take CTBS, beginning in 1990 the CTBS will be replaced with Stanford-8 exam), the state calculates the actual gains made by each student.

(3) The predicted gain is then subtracted from the actual gain yielding a gain index for each student. A positive result represents the amount by which the student has exceeded the level of achievement gain given the student's previous performance and the average gain typically achieved by such students across the state.

(4) The median of individual student gains becomes the SGI for the school. The state assumes that SGIs, if positive, are a school effect.

Schools with the largest SGIs receive cash awards of up to $30 per pupil. In this way, SIRP brings home the consequences of student performance on standardized achievement tests to faculties and administrators. The state reduces SIRP for schools in which teacher or student attendance rates fall below 95 percent. Schools forfeit 20 percent of their SIRP award if both attendance rates are below the standard. May and Mandeville (1987) give further information on the calculation of SGIs.

The state uses both BSAP and CTBS scores in calculating SGIs and determining SIRP awards, because the CTBS is not given in tenth grade when the state requires students to take the BSAP. The state decided to introduce BSAP and not to rely entirely on a nationally standardized test of basic skills in order to get a better understanding of the performance of schools within the state relative to one another. The decision to tie funding to a state- designed test increases state control over the specific content on which teachers must focus if they wish to win funds allocated on the basis of test performance.

The SIRP provisions described above represent state efforts to control for educational inputs, or the "raw materials" with which schools work. In the view of state policymakers, maximizing school participation in SIRP requires eliminating the role of factors beyond the schools' control when formulating award criteria. From the state's perspective then, the achievement level of incoming students, their socioeconomic status, and the composition of the faculty represent factors beyond the control of the individual school.

In addition to specifying what schools must do to win SIRP funds, the state regulates how the money may be spent. Under the EIA, each school is required to form a School Improvement Council composed of parents, teachers, and building administrators to make decisions about SIRP expenditures. The council does not have free rein but may only use SIRP funds to further improve educational programs. The funds must not supplant regular district funds, nor can they be used to augment salaries. Many schools use SIRP funds to purchase computers and lab equipment. Some schools, at the behest of teachers, have used SIRP money to buy photocopiers.

The Teacher Incentive Program

Policymakers realized from the outset that not all teachers would respond favorably to SIRP. Some teachers could not be expected to value additional instructional resources for their school—especially in light of the extra effort required to procure the funds. For this reason, the Teacher Incentive Program (TIP) was added to the EIA package.

Like SIRP, TIP relies heavily on the use of incentives by arguing that teachers should be rewarded directly and individually for improved performance. Pointing to the effectiveness of monetary incentives in the private sector, policymakers, backed by the business sector, argued that teachers would work harder to "produce" test score gains if allowed to benefit personally from improved student performance. In the end, the legislature included a plan to provide cash bonuses of $2000 $3000 for teachers who could demonstrate their own contribution to improved student performance. The state planned to implement TIP gradually, initially allocating $600,000 for TIP planning for 1984-85. A third of this amount was actually spent to develop TIP campus and individual plan models. In 1985-86, the state spent about $2.1 million to pilot TIP in 9 of the 91 districts. This was to be followed by an investment of over $21 million to implement TIP statewide in 1986-87. However, due to funding problems and negative reactions from some districts and teachers, statewide implementation was postponed. Instead, the state spent about $5.8 million to expand the TIP program to 17 districts. In 1987-88, the state spent about $11.5 million to conduct the program in 44 districts. In 1989-90, TIP reached its funding peak as it was implemented statewide. TIP then went into decline as criticism of the program continued. Although the program remained on the books in 1990-91, the legislature allocated no money for it.

We have no definitive data on how many teachers actually received TIP bonuses in the years noted above. The state estimates that TIP bonuses raised the average teacher "salary" by $325 in 1987-88. If the average TIP bonus was $2,500, that would suggest that about one in eight teachers received money through the program in that year. In 1989-90, when TIP was implemented statewide, one in every four full-time teachers, counselors, and librarians, approximately 9000, received TIP awards averaging about $1700 each. TIP's life cycle resembles that of a similar teacher incentive program in Florida (see Arthur & Milton, 1991).

A similar program, the Principal Incentive Program (PIP) was also created in South Carolina to reward principals for their own contributions to "increased productivity." PIP gives $2500 - $5000 to principals in schools with high SGIs. None of the EIA literature we have offers a rationale for giving principals larger bonuses than teachers.

TIP's resemblance to SIRP was not restricted to its reliance on cash incentives. In formulating the specific criteria for TIP awards, the state once again sought to maximize participation. This desire led to the adoption of a two-pronged program in which teachers could choose between a "campus plan" and an "individual plan" for "earning" TIP bonuses or opt out of the program entirely. In some districts the central administration has decided that all schools should use the same plan. In other districts the decision is left to a School-Based Management team or other party at the school level. TIP bonuses in the campus plan are based on School Gain Indexes as calculated in SIRP. If the school qualifies for SIRP awards, then teachers also receive TIP bonuses for their contributions to improved performance. Teachers who fail to report to work at least 95 percent of the time are not eligible for TIP bonuses. In this way, TIP reinforces BSAP's attempt to focus the organization's energy on basic skills intensification.

Although policymakers expected the TIP campus plan to influence instruction in some schools, they recognized that others would not be swayed by the incentive. Indifference to TIP seemed especially likely in schools where the majority of teachers would not expect even their best efforts to result in awards. Although TIP could not overcome this obstacle, steps were taken to involve individual motivated teachers who happened to work in schools where most teachers showed little interest in incentives. The individual plan in TIP allows some teachers to compete for TIP incentives, irrespective of whether their colleagues do.

The state's decision to involve individual teachers in the quest for improved academic performance presented special problems. The campus plan allowed the state to use standardized test scores to evaluate whole schools, but such tests cannot be used to assess the effectiveness of individual teachers. There is often no clear correspondence between the curriculum of a given course and the knowledge tested on standardized exams. Indeed, subjects such as science and social studies are not even covered on the high school BSAP. For this reason the state needed a different set of criteria for assessing the effectiveness of teachers choosing the "individual" TIP plan. The state responded to this assessment problem by creating "Student Achievement Proposals." In these proposals, teachers established goals at the beginning of the year for improved student performance in each of their classes. Teachers often use their knowledge of how students have performed in a course in the past as baseline data for assessing what will constitute superior performance on the part of their current students. Although various criteria may be used to measure student performance, the final grades of students in the class are commonly used as the main criterion. In addition to providing a summary of final grades for their classes, the state requires teachers to keep student portfolios with representative work. Presumably this prevents teachers from using easy assignments or lenient grading as a way to win an award. TIP awards then went to teachers who, at the end of the school year, provided evidence that they had met their goals.

In addition to maximizing the number of teachers having access to TIP incentives, the individual plan guarded against predictable criticism. For example, without the individual plan, the state might have been accused of rewarding ineffective teachers who were lucky enough to work in basically successful schools, while ignoring effective teachers who happened to work in unsuccessful schools. Although the individual TIP plan did not prevent awards from going to ineffective teachers in schools that win SIRP money, it created a mechanism for recognizing effective teaching in the remaining schools.

From the state's perspective, having all schools select the TIP campus plan would be preferable because it encouraged teachers to focus directly on raising standardized test scores. Furthermore, since everyone profited or failed together under the campus plan, basic skill intensification was likely to get an added boost from teachers who put pressure on their colleagues to support the effort. Some consequences of the state's decision to use two sets of criteria for determining TIP awards are discussed in the South Carolina school case studies. The important point here is to recognize how the decision itself reflected an underlying policy objective of the state: to maximize teacher commitment to improved academic performance. Irrespective of other consequences, a two-track TIP plan might reasonably have been expected to do just that.

Sanctions in EIA Policy

Although South Carolina reform policies heavily emphasize incentives, EIA also includes sanctions for districts that fail to meet minimal standards for basic skills achievement. For example, the bill empowers the state superintendent to declare school districts officially "impaired" and, with the support of the state Senate and House Education Committees, to declare a "state of educational emergency" in such districts. Having done this, the state superintendent assumes broad powers to evaluate district programs and recommend improvements that must be made before the district can return to unimpaired status. If an impaired district shows no improvement after six months, the state superintendent may order the district Board of Trustees to replace the district superintendent.

EIA also empowers the state superintendent to withhold all EIA funds from districts that remain on the "impaired" list for more than six months. Of course, SIRP and TIP awards are not affected by this policy because impaired districts are unlikely to be competitive for such awards anyway. However, EIA also provides districts with major funds for remodeling and building schools; for expanded programs in compensatory education, early childhood education, gifted and talented and special education, vocational education, and continuing education for teachers; and for purchasing computers and other instructional materials. The loss of state funds for these purposes would devastate any school district. Although the state declared ten school districts to be "impaired" from 1984 to 1989, all of these districts demonstrated substantial improvement during the subsequent six-month probationary period, thereby maintaining their eligibility for EIA funding.

EIA sanctions are intended to complement incentives and further encourage schools to emphasize basic skills instruction. The basic skills orientation is evident in the criteria EIA instructs the state superintendent to use in determining whether a school district is educationally "impaired." The impairment criteria, as described in EIA legislation, are: "(1) improvement [or lack thereof] of Statewide Testing Program and BSAP test results; (2) dropout rate; (3) accreditation deficiencies; and (4) failure rate on high school exit exam" (Education Improvement Act of 1984). In effect, school districts run the greatest risk of being deemed impaired if they disregard the state's emphasis on BSAP and basic skills. The fact that schools are also required to maintain accreditation and keep their dropout rate below a certain level does not detract from a basic skills emphasis. The state makes graduation itself largely dependent on BSAP scores. Again, the separate provisions in this part of EIA mutually reinforce a basic skills emphasis.

Other Aspects of the EIA Initiative

Although the above discussion emphasizes the role of incentives and sanctions in conveying the underlying objectives and rationale of the EIA, the EIA allocated large sums for education with no strings attached. For example, during the first two years of the EIA, the state gave districts $39.6 million (1984-85) and $22.2 million (1985-86) to renovate existing schools and build new ones (South

Carolina Department of Education, 1988). In a similar move, the state gave teachers substantial across-the-board raises at the same time TIP was introduced. EIA also entailed a commitment by the state to raise the average teacher salary in South Carolina to the regional average over a three-year period. Consequently state contributions to teacher salaries went from $59.5 million in 1984-85, to $72.7 million in 1985-86, to $85 million in 1986-87, and to $97.2 million in 1987-88. During this period the average salary for teachers in South Carolina climbed from $20,140 to $24,720.

It is instructive to compare the magnitude of state expenditures on across-the-board salary increases to salary enhancements effected through TIP. While the state funneled over $314 million into regular salary increases from 1984 through 1989, along with another $46.6 million in related fringe benefits, only $35.3 million were spent on TIP; TIP represented only a small fraction of sharply increased state contributions to teacher salaries (South Carolina Department of Education, 1990, pp. 26, 50-51).

The relatively modest allocations for TIP raises questions about whether policymakers actually expected TIP to have much concrete impact. Here we must bear in mind the political climate in which the legislature, state education agency, and governor hammered out the details of EIA. As noted above, South Carolina entered the 1980s with one of the lowest average teacher salaries in a region that was already at the bottom nationally. Districts statewide were under pressure from teachers and others to match the salary levels of surrounding states. Many school boards, knowing they could not accomplish this alone, supported those who felt the state should act to boost salaries.

Once policymakers committed themselves to raising teacher salaries, they faced questions about implementation strategies. Although much of the money for higher salaries was allocated irrespective of school or teacher performance, the addition of TIP gave special meaning to the increases for teachers and for the public. In the absence of a program such as TIP, the state would have been preparing to give teachers more money without gaining greater influence over how or what they teach. By putting money into TIP, the state created another mechanism for focusing teachers' attention on basic skills. Once TIP was added to the reform package, policymakers--especially state legislators--could point to TIP when assuring taxpayers that they would "get a return on their investment." They could emphasize that only effective teachers (namely those "producing" higher test scores) would get special dispensation, while de-emphasizing the fact that the bulk of new expenditures for teacher salaries would go to general salary increases.

In addition to giving policymakers greater influence over curriculum, TIP entailed little or no added long-term expense. The fact that the state did not significantly increase its overall expenses to fund TIP becomes apparent if we examine how the program was administered in relation to across-the-board salary increases. As noted above, the EIA committed the state to raising teacher salaries to the regional average. Although basing the target salary on the regional average placed salaries somewhat beyond the control of South Carolina's policymakers, it did not mean that all methods for reaching the goal would be equally costly. To understand this, we must see how TIP funds were treated when calculating the average teacher salary.

When the state calculated the average teacher salary in 1986-87, money given to teachers in the form of TIP incentives was not counted. Had the state included the amount paid out in TIP incentives during that period, the total amount paid to teachers would still have been insufficient to push the average salary for South Carolina teachers up to the regional average. If the state had used the same accounting method in 1987-88, the average South Carolina teacher salary would once again have fallen below the regional average. However, realizing the average salary in South Carolina was now very close to the target salary, the state altered its accounting methods to include TIP monies in calculating the average salary. At this point TIP ceased to represent an added cost for the state; the combined cost of across-the-board salaries plus TIP was now going to be precisely the same as the cost of maintaining the regional average outright. So long as the state intended to maintain its

301

progress toward the goal of paying teachers at the regional average, and so long as the state was going to continue to count TIP bonuses when calculating average teacher salaries, South Carolina was going to get TIP for free.

The state's SIRP program can also be seen as a policymaker's dream--to the extent that it has the intended effect on schools and teachers--because, like TIP, it entails little additional cost. The nature of the funding mechanism for the EIA as a whole, which is discussed below, created a spending ceiling for the entire EIA initiative. Thus, the state had little to lose and much to gain by creating the SIRP program with some of the money that might have been given to schools with no strings attached. As with TIP, it gave the state one more mechanism for focusing schools' instructional programs on basic skills. Moreover, programs like SIRP and TIP reassured the public that money spent on EIA would yield concrete benefits. Legislators argued that the new money would not be squandered on ineffective teachers and poorly administered schools. Instead, the new money would raise expectations and performance throughout the educational system by going to schools and teachers who demonstrate improvement.

Making EIA politically attractive was important due to the large expenditures involved. To fund the program, the governor proposed to increase the state sales tax from four cents on the dollar to five. The new revenues would be used to fund the various programs in EIA and would represent expenditures on top of previous state support for education. The new tax was subsequently legislated and EIA was implemented in 1984, raising on average upward of $200 million per year since then. Total state educational expenditures rose from $799 million in 1982-83, the year before EIA, to about $1.2 billion in 1986-87 (Putka, 1988). It was to be expected that the public and the press, as well as political and educational actors, would follow closely this dramatic increase in state expenditures for education.

EIA policies reflected pragmatic political realities as well as a commitment among South

Carolina legislators and others to raise standardized test scores. There was something in the plan for teachers as well as schools. And because it promised better basic skills for children, it appealed to many parents and employers as well. In short, policymakers believed the EIA would receive wide support if it addressed the needs and interests of all important actors in the educational arena.

Other Salient State Policies

An assessment of the major effects of EIA initiatives such as BSAP, SIRP, and TIP on state districts and schools, and ultimately on students, is discussed elsewhere in this report, especially in the case studies of South Carolina schools included in this chapter. Without delving into specifics, we note here that the impact of key EIA initiatives was tempered by a host of other state policies.

For example, the state has policies that go beyond BSAP, SIRP, and TIP. Some of these other policies were enacted as part of the EIA, whereas others predate the 1984 initiative. These policies can work to reinforce, modify, or undermine EIA policies. Other important areas affected by state policies include graduation and university admissions requirements, curriculum frameworks, textbook adoption, teacher certification, and professional development. State policies in these areas that impact high school math and science are described below.

State Graduation Requirements

Prior to 1984, students could graduate from South Carolina high schools with 2 credits in math and 1 in science. The EIA raised graduation requirements for math and science and other subjects, beginning with entering freshmen in 1984. Since 1984 a regular diploma has required 3 credits in math and 2 in science. The state also adopted a new policy at that time requiring all science courses to devote 20% of instructional time to labs. In conjunction with increased requirements for a regular diploma, the state introduced special college-preparatory diplomas for college-bound students. A College-Prep diploma is needed to qualify for admission to the state university and requires that students complete 4 credits in math (including Algebra I, Geometry, and Algebra II) and 3 credits in science (including 2 credits in upper-level lab courses such as Biology, Chemistry, or Physics).

It is instructive to compare some of the intended effects of increased graduation requirements with the intended effects of the BSAP program. For example, basic skills intensification has no practical implications for college-bound students since they typically master basic skills long before they are examined on them. However, increased requirements for a college-preparatory diploma and college admissions may substantially affect course-taking among the college bound. The requirements for the college-prep diploma are especially relevant for students who, in the absence of increased requirements, would stop taking college-prep courses earlier in their career. The fact that the new college-prep requirements specify advanced courses as part of the college-prep program is likely to increase their impact. The requirements function generally to increase the breadth of the subjects studied by college-bound students in both math and science.

The increased credit requirements for the regular diploma are not likely to affect general track students in the same way that the college-prep requirements affect the college bound. General track students can acquire the necessary number of credits without expanding the breadth of subjects they study. For example, students can satisfy the math requirement for a regular diploma by taking three years of General Math. Also, students who choose a vocational studies program may graduate with only one credit in science and may substitute a credit of computer science for one of their math credits. No clear explanation was given for why students in the vocational track had a lower graduation requirement for science. Many administrators noted that vocational course enrollment fell precipitously as general and college-track students became subject to higher graduation requirements in traditional academic subjects. It is conceivable that the state anticipated this and excluded vocational track students from some of the new requirements in order to avoid undermining vocational course taking among students in the vocational track. South Carolina is not the only state where enrollment in traditional vocational subjects is thought to be declining; administrators in Florida and Missouri also reported this trend.

The state has selected two distinctly different mechanisms for increasing the minimal requirements for general and college-prep students. BSAP is designed to increase minimum standards for the noncollege bound but is not expected to directly affect college-prep students. Increased graduation requirements, on the other hand, increase minimum standards for college-bound students although there is no expectation that they will have an equivalent effect on others. These two measures, each of which was undertaken by the state to increase standards for different segments of the student population, bear one important similarity: both are intended to boost achievement and intensify emphasis on traditional content for the segments of the student population they affect.

State Curriculum Frameworks

South Carolina exercises little control over the curriculum of most high school courses. The state exerts some influence by establishing a list of state-adopted courses and stipulating that only courses on that list may fulfill basic graduation requirements. However, insofar as content is concerned, the state provides only general outlines of key objectives for most of the courses on the state list. Exceptions, at the high school level, are those courses that cover material examined on BSAP. As noted previously, the state provides teachers of lower-level math courses with extensive manuals for teaching BSAP objectives.

Textbook Adoption

The state department of education exerts considerable control over textbook selection by requiring districts to choose books from a list of state-adopted texts. The state follows a six-year adoption cycle and selects five books for each state-approved course. Districts make their selections from the state list and submit their choices to the state department of education, which then orders and pays for the texts.

State textbook adoption committees have nine members, including teachers, curriculum specialists, and a layperson. Committee members are supplied with a state publication entitled "Textbook Adoption Regulations"; however this pamphlet does not specify substantive criteria for textbook selection. A state department of education official who regularly chairs textbook adoption committees says texts are often ruled out for being too easy or too difficult for a particular course or grade level. She also says compatibility between texts and state-approved course outlines is a key consideration. However, it does not seem likely that this criterion would permit the committee to rule out very many texts, because the state course outlines are so general.

Teacher Certification

Teacher certification has received little attention in South Carolina. The state grants initial certification to anyone who completes a teacher training program approved by the state board of education and passes the National Teacher's Exam (NTE). Certification programs are typically approved if they conform to standards set by the National Association of State Directors of Teacher Education and Certification. States set their own cutoff points for a passing grade on the standardized NTE. South Carolina, beginning in 1989, required teachers to score at least 642 on the professional knowledge portion of the exam.

South Carolina's policies on teacher certification appear minimal when juxtaposed with state policymaking activity in areas such as basic skills, paralleling the relatively low priority South Carolina gives to professional development.

Professional Development

Although South Carolina has initiated new programs to improve staff development for continuing teachers, state policies and expenditures for this purpose remain modest. In 1986-87, the state introduced its "Program for Effective Teaching" (PET) and spent $1.2 million per year over four years to train 6000 teachers and administrators. These evaluators observe first-year teachers to check for minimum classroom competencies. PET emphasizes pedagogical and classroom management practices based on the effective schools literature of the 1970s and 1980s. It is not designed to influence course content.

Other major state efforts to bolster professional development are found in the state's "Critical Needs Certification Program" and the "Teacher Loan Program." The former program is designed to reduce teacher shortages in certain geographical areas and subjects. The program allows individuals with college degrees in fields other than education to teach while pursuing certification, providing they work in an area of critical need. A vast majority of the 300 individuals who participated in the program from 1984 to 1988 were pursuing certification in high school math and science and working in rural schools. The Teacher Loan Program is designed to help prospective teachers with college expenses. Program participants receive state loans if they declare their intention to work in a state-defined area of critical need on being certified. Those who subsequently work in such areas have 20% of their loan forgiven for each year spent there.

Although the Critical Needs Certification and Teacher Loan Programs have been included in this section on professional development, these programs do not represent key state strategies for changing teacher practice. In effect, these programs reflect a much higher priority on recruiting new teachers than they do on influencing practice among continuing teachers. Furthermore, they are only stopgap measures to reduce severe shortages that persist despite the absence of rigorous general certification requirements. State efforts to promote professional development for continuing teachers remain modest. Many inservices the state provides for continuing teachers focus on BSAP implementation and other topics that have little potential to alter traditional content and pedagogy.

The only workshops provided regularly by the state for the purpose of changing traditional content and teaching strategies in high school math and science are funded with federal Eisenhower dollars. Thousands of teachers attend one- to three-hour Eisenhower-supported workshops each year. Several hundred teachers receive more extensive exposure to new approaches through Eisenhower-funded graduate level courses. These courses use outlines designed by state department of education curriculum specialists and emphasize subject area content. Using Eisenhower money, the state reimburses teachers for tuition after course completion.

Summary of South Carolina State Policies

The Education Improvement Act of 1984 is the centerpiece for school reform in South Carolina. The heart of the EIA consists of three highly interdependent state programs: the Basic Skills Assessment Program, the School Incentive Reward Program, and the Teacher Incentive Program. Together these programs make student achievement on basic skills consequential for students, teachers, and administrators.

EIA uses both sanctions and incentives to encourage compliance. Both implementation strategies are designed to engender aggressive pursuit of state policy objectives at the local level. Generally speaking, sanctions are used to enforce minimal performance levels, whereas incentives are used to elicit superior performance. Both strategies encourage direct competition between teachers and schools. In several cases we saw teachers and administrators urge students to dedicate themselves to this competition by stressing how their school would benefit financially from higher test scores. Yet the state takes steps to emphasize improvement in academic achievement over absolute scores and to equalize the basis on which schools compete by controlling for external factors, such as SES.

The state regulates areas not covered by major EIA programs. Many of these areas were regulated prior to EIA, but regulations have since been revised to reinforce EIA emphasis on basic skills. For example, graduation requirements have been increased for general and college-bound students. Especially for the latter group, the new requirements are designed to increase the breadth of subjects students study. State textbook adoption policies potentially exert an indirect influence on course content, but the state does not have detailed curriculum frameworks to guide textbook adoption or to govern course content, except in the case of BSAP instruction. Teacher certification has low priority in the state, and staff development is sporadic at best. State policy concentrates on recruiting new teachers to math and science rather than on changing the practices of those already in the field.

In 1991, the TIP program, although still formally on the books, received no allocation from the state legislature. Lack of funding was probably due in part to a lagging economy and reduced tax receipts with which to fund EIA. But TIP also proved to be highly divisive within some school districts and schools. This topic is discussed further in case study S3.

Part II: District Policies in South Carolina

District school boards and administrators stand between the state education agency and principals and teachers in their local schools. Even before teachers decide whether to accept, reject, or modify state policies, district-level decisionmakers act to mediate state policies for local interpretation and implementation. Districts also act independently to create policy in areas not regulated by the state. When district-initiated policies become highly salient, they may displace state-level priorities.

This section summarizes policies in RUC's two South Carolina districts and notes where such policies support, undermine, or depart from state policy. Since schools operate under the umbrella of both district and state policy, the information in this section will provide the reader with a better basis for understanding the policy context of individual schools.

Key Policies in District A

District A is predominately urban and contains twelve high schools, including the two South Carolina urban schools studied by RUC. The district serves about 45,000 students, making it one of the largest districts in the state. Students come from a broad socioeconomic range. About 25,000 (56%) of the students are black, 18,500 (42%) are white, and 730 (1.7%) are classified as "other." Many of the district's black students are concentrated in the inner city schools in the district's large metropolitan area, while the suburban schools are disproportionately white.

District A has a well-developed administrative bureaucracy and a school board criticized by teachers and administrators for its tendency to micromanage the schools. This combination of factors has yielded an elaborate set of formal policies at the district level.

District Endorsement of State Policy

Many policies in District A serve only to endorse, reiterate, and provide concrete implementation procedures for state policies. For example, the district testing program requires high schools to administer BSAP in tenth grade and the Stanford-8 in grades 9 and 11. It requires schools to follow strict state standards for test security and provide remediation for students who fail BSAP.

District policies on professional development and teacher evaluation also reflect state policy. The district plans for only as many inservice days as the state requires. Since the district relies heavily on Eisenhower money forwarded by the state for inservices and continuing education courses, the state often stipulates the content as well as the extent of such activities. The district has no special requirements for continuing education and makes no concerted effort to change the classroom practice of teachers already in the field. Evidence of the low priority given to dissemination of information to continuing teachers is the fact that there is only one district curriculum specialist in science for 1500 science teachers.

District A conducts extensive teacher evaluation. New teachers are observed three times yearly, teachers who have worked in the district three or more years are evaluated each third year. Teachers are evaluated by their principal or one of their assistant principals as well as by another teacher in their subject area from another school in the district. Observers rate teachers on planning, instruction, classroom management, communication, and adherence to policy. Evaluators use a checklist of behavioral objectives to assess whether teachers exhibit appropriate behaviors in their classrooms. Teachers who exhibit less than 80% of the 52 desired teacher behaviors go through cycles of remediation and are reevaluated until they are deemed proficient.

The district also follows the state's lead on course offerings. Each school must satisfy the state's Defined Minimum Program (DMP) requirement before offering other courses from a more expansive list of state-adopted courses. All courses included in the course sequence recommended by the district, as shown below, are included in the state DMP.

General

General Math I	General Physical Science or General Science
General Math II	General Biology I
General Math III	Physics for the Technologies,
Business Math	Environmental Studies, or General Marine Science

College Preparatory

Algebra I	CP Physical Science
Geometry	CP Biology I, II
Algebra II	CP Chemistry I, II
Precalculus	CP Physics I, CP Marine Science, or
Calculus	Astronomy

Honors

Honors Algebra I
Honors Geometry
Honors Algebra II
Honors Precalculus
AP Calculus or Honors Statistics

Honors Physical Science
Honors Biology I
Honors Chemistry I
Honors Physics

District Extension of State Policy

An example of a district policy that acts to strengthen or extend a state policy is found in course-level exit exams, or area exams as they are often called, initiated by the district. In 1990, District A had area exams for General Math and Algebra I in place and was piloting a third in Physical Science. Curriculum specialists also reported tentative plans to develop area exams for other high school courses.

District A area exams resemble the state BSAP exam in two fundamental ways: (a) they reflect a desire by administrators to influence instruction by intervening in student assessment and evaluation, thus challenging the traditional authority of teachers to control this function; and (b) they share a common underlying logic of evaluation.

Although states have for some time now involved themselves in student assessment by administering standardized norm-referenced tests, the last decade has been witness to increased use of standardized tests by states such as South Carolina for student evaluation. By using BSAP to gain control over minimum standards for high school graduation, the state has effectively intervened in an area where classroom teachers have traditionally been the ultimate authority. Increased state power substantially alters the relationship between schools and the state, especially from the perspective of students who instantaneously become accountable to two distinct sets of criteria instead of one. The creation of district area exams introduces yet a third player and set of standards into the evaluation arena. Increasing the number of actors who influence student assessment and evaluation dilutes the traditional authority of classroom teachers in this area.

The similarity between the district and state exams is not restricted to the way they function to regulate student progress through standard course sequences; the state and district exams have the same underlying premise about the appropriate form or method of evaluation. Like the state's BSAP exit exam, district area exams are premised on the logic of the minimum competency approach to standards. This logic is implicit in the fact that exit exams are intended only to insure that students have acquired a minimum number of specific skills and are not meant to assess the full extent of student learning across the course curriculum.

Although both district and state exit exams assume the appropriateness of minimum competency evaluation, they test substantially different content. Content differences occur because district area exams are based on district curriculum guides, which, as we discuss in District Modification of State Policy, are designed to reflect NCTM's emphasis on teaching for conceptual understanding (TCU), problem solving, and HOTS. To the extent that the guides do emphasize HOTS, and if the area exams are based on the formal curriculum therein, the district is using a minimum competency approach to assess student achievement on state-of-the-art content. This possibility deserves further consideration.

Closer examination of the content of district area exams provides evidence on the extent to which District A has incorporated HOTS and TCU into curriculum guides and the tests themselves. Although the district did not share a copy of an actual exam, we were provided with a document called the "Physical Science Test Blueprint." This blueprint describes the content areas and item types to be included on a Physical Science area exam, slated for piloting in 1990-91.

The test blueprint for ninth-grade Physical Science conforms to the course curriculum guide by dividing course content into the two main areas of "chemistry" and "physics." Content areas identified for testing within chemistry, along with the percentage of test items targeting each area (percentage shown in parentheses), include properties of matter (19%), structure of matter (21%), compounds and bonding (17%), chemical reactions (24%), carbon chemistry (12%), and nuclear reactions (7%). Physics test items are distributed as follows: forces (13%), motion (17%), work and power (16%), energy (13%), sound (9%), electricity (12%), light (9%), and heat (11%). The blueprint also specifies cognitive processes that test items are intended to assess. Classifying the items on this dimension yields the following distribution: knowledge (24.5%), comprehension (24.5%), application (24.5%), analysis (7.5%), synthesis (4.5%), evaluation (2%), and experimental measurement/scientific method/lab procedures (12.5%).

The descriptors used on the blueprint to identify different cognitive processes do not clearly convey the nature of actual test items. Our interviews show that district personnel who write and pilot the tests believe problem solving and HOTS are emphasized more on district tests than they are on the state BSAP. An administrator from the district's Office of Research and Evaluation said the knowledge and comprehension items on the district tests are comparable to basic skills items that constitute the whole of the state exam, but that the analysis, synthesis, and evaluation items on district exams are aptly characterized as HOTS, while district Application items fall somewhere between. Thus, about 14% of the items on the district Physical Science test are ones that district personnel themselves classify as HOTS.

For this reason, district personnel believe their area exams are more intellectually demanding than the state BSAP exam. If pass/fail rates are an indication of this, then evidence exists to support their view: students fail district area exams at a far greater rate than they fail the state BSAP exam. To examine student performance on district area exams, we must turn our attention to mathematics, because the Physical Science exam is still being piloted and does not yet play a role in student retention. The district has used mathematics exams to determine whether students may receive credit for General Math I or Algebra I, irrespective of the grade they receive from their classroom teacher.

In 1989-90, students were required to answer correctly 35 out of 77 items on the General Math I exam and 31 out of 69 items on the Algebra I exam to receive course credit. In 1990-91, the cutoff scores were raised to 38 of 77 in General Math I and 34 of 69 in Algebra I. In 1990-91, according to the district's department of research and evaluation, of the 1224 high school students who took the General Math I area exam, 220 (18%) failed. A total of 1464 students took the district Algebra I area exam, 366 (25%) of whom failed. The failure rate for district math course exit exams is higher than the failure rate in the tenth-grade BSAP math test used by the state as a high school exit exam. In District A, in 1990-91, over 86% (up from 67% in 1985-86) of the students who were taking the tenth-grade BSAP for the first time passed the math portion of the exam.

These tests have profound implications, since students cannot advance in the district math sequence until they have retaken failed courses and passed the area exam. In a district and state where students must earn three credits in math, including Algebra I, Geometry, and Algebra II, to qualify for admission to a state college, extensive use of exit exams does not leave students with much of a cushion. This discussion permits two conclusions: (1) District A's area exams appear to involve more complex concepts and place greater emphasis on problem solving than the state basic skills exam, and (2) students fail the district exams at a much greater rate than the state BSAP exam.

For the purposes of this analysis, little more need be said on the first point: either district tests involve relatively complex, advanced tasks, or they do not. The evidence we have from district curriculum guides, test blueprints, and descriptions of the test content by the district personnel who write them suggests that the exams are more challenging than those administered by the state. The second point requires further examination because student success and failure rates are not inherent to the format of an exam. Rather success is also a function of the instruction students receive in preparation for an exam. Before we conclude that district exams are simply more difficult than the state exam and that students will therefore always fail them in greater numbers, we need to look at key policies affecting instructional practice. More specifically, we must compare state and district policies affecting instruction as it relates to conveying basic skills and HOTS content to students. If District A is increasing the salience of HOTS on area exams, is the district also adapting its instructional policies to facilitate teacher and student success on the new content?

Interviews with four district curriculum specialists and central administrators reveal much doubt about whether students are well prepared to take district exams. One curriculum specialist stated unequivocally that she would prefer to discontinue the tests. Like others, she believed that fewer than 25% of district teachers follow the curriculum guides on which area exams are based. She interprets this as conclusive evidence that many students do not have sufficient exposure to exam content before they take the tests. In her judgement, some students are seeing certain types of content for the first time when they sit for district area exams. To understand how the district comes to find itself in the position of failing up to a quarter of the students in basic courses and how this failure stems from the use of an exam that receives little support from district administrators, we must examine the policymaking role of the local school board; District A area exams are a board initiative.

As noted earlier, District A's board is frequently criticized by teachers and administrators for micromanaging the schools. Since the early 1980s, the board has sought to reduce teacher control of curriculum by requiring teachers to use district curriculum guides, which themselves have been made increasingly specific. This development, along with the board's decision to intervene directly into student assessment through the use of area exams, is seen by many teachers as an attempt to circumvent the traditional authority of classroom teachers.

Although District A's board was quick to follow the state in mandating course-level exit exams, the board ignored the fact that the state had developed a systematic plan for implementation of the tests. The board's inattention to implementation strategies may contribute as much to student failure as does difficult exam content. Direct comparison of state and district implementation strategies reveals two highly problematic assumptions made by District A's board. The first assumption is that policies tying student promotion to test scores will be effective in the absence of teacher sanctions or incentives, or both. The second assumption is that intensification of existing classroom practice will increase student achievement on problem solving, TCU, and HOTS in the same way that it stimulates basic skills achievement. These assumptions are examined below.

State strategies for improving scores on BSAP not only put greater pressure on students to succeed, but also provided sanctions and incentives to encourage teachers and administrators to deliver instruction expected to improve student performance. District A makes no attempt to render student performance on area exams consequential to teachers and administrators. Apparently the board assumes that adopting a policy instructing teachers to adapt their classroom practice to the new tests insures that this will in fact occur. Evidence presented in this section, and other information included in the school case studies from District A, shows that this assumption is erroneous: many teachers do not use the curriculum guides on which district exams are based.

The fact that teachers have thus far ignored or discounted district policy on curriculum guides and testing does not appear to present an insurmountable obstacle. The state has already demonstrated the effectiveness of monetary incentives for convincing teachers that it is worth their while to support policies of this type. The second assumption, that teachers currently possess the content and pedagogical knowledge needed to prepare students for district exams, may prove more vexing. When state policymakers asked teachers to alter their classroom practice, they limited their mandate by asking only that teachers become more efficient at conveying the type of content they had been teaching more or less successfully all along. Basic skills intensification did not require teachers to fundamentally change their content knowledge or pedagogy.

District A's board, however, is asking teachers to prepare students for minimum competency exams that include HOTS and problem-solving tasks. According to groups such as NCTM and NSTA

(National Science Teachers Association), who promote curriculum reform of this type, conveying this type of content requires different instructional practices, which, in turn, require nontraditional knowledge about content and pedagogy. Recent research corroborates this view and further suggests that many teachers lack the content and pedagogical knowledge needed to teach this way (Cohen, 1990; Firestone, Fuhrman, & Kirst, 1991). RUC log data, as discussed in Chapter 5, also indicates that instruction for conceptual understanding and HOTS is sporadic.

Despite current research on instruction geared to TCU and HOTS, District A has increased the salience of such curricula without a strategy for supporting teachers who wish to acquire the knowledge and skills needed to implement such curricula. For example, the district is content with meeting state minimum requirements for teacher workshops and inservices. Furthermore, as our interviews and weekly questionnaires from log teachers show, inservices on curriculum guides and tests are usually restricted to familiarizing teachers with new instruments and bureaucratic considerations such as who should use the instruments, when they are to be administered, how they are to be distributed, and so forth. Inservices rarely address subject area knowledge or cognitive processes in learning.

District A's attempts to extend or strengthen state policies reflect expanded use of a particular type of assessment instrument, namely minimum competency exams, first utilized by the state department of education. Like the state, District A bases student promotion and retention on test performance. The district then goes one step farther by also using test scores to calculate course grades, even for students who meet the minimum criteria on the exams. Unlike the state, the district has not introduced the new assessment instruments as part of a more systematic revision of policy affecting curriculum and instructional practice. The resulting situation is one in which the curriculum delivered by district teachers may be poorly aligned with student assessment instruments over which teachers themselves have little control.

District Modification of State Policy

District A also uses policies to modify state mandates. A key tool developed by District A for this purpose is the district curriculum guides. A close look at the nature of the guides permits a fuller understanding of their uses and limitations as instruments for redirecting state policy on course content and pedagogy.

District A expends considerable resources to develop detailed curriculum guides for every course and to provide them to all teachers. Most guides follow a common format wherein courses are divided into semesters and units. Within each unit, guides specify behavioral objectives intended to inform teachers' decisions about content, pedagogy, and evaluation. Guides also include lessons for complete units. For example, the Physical Science guide, which totals 260 pages, contains an introductory unit on measurement, scientific method, and lab safety. The 50-page unit addresses concepts and suggests classroom activities for teachers. The guide also tells teachers where to find additional information on a topic in their textbooks.

It is difficult to determine effects of District A's curriculum guides in relation to state curriculum policies. Until recently, curriculum guides in District A emphasized traditional content and pedagogy; they failed to capitalize on the broad range of discretion permitted by state policies based on course outlines that are too general to significantly limit curriculum. Recently, however, district curriculum specialists have endeavored to revise curriculum guides to incorporate more course content and pedagogy of the kind advocated by groups such as NCTM. Some of the revised guides are in the schools; others will soon be in place.

The actual impact of the revised guides is an empirical question. In fact, although teachers are contractually required to adhere to curriculum guides, there is no system for monitoring compliance. These issues will be revisited in the school case studies. However, here we treat the policy on district guides as one intended to modify rather than merely strengthen or extend a state policy because it entails a conscious effort by the district to effect curricula that are qualitatively different from those contained in state documents governing course content.

The district policy on curriculum guides is also intended to increase district control of course content by affecting which textbooks are ultimately selected. As noted previously, textbook selection begins with the state, where five texts are adopted for each course. Districts then make final selections from the state list. In District A, all teachers of a given course are required to use the same text. The particular texts to be used are chosen by a committee of district curriculum specialists, principals, and teachers.

Several factors combine to maximize district influence over the final textbook selections made by district committees. First, the district has elaborate rules specifying the criteria and procedures to be used. One rule instructs committees to map prospective texts onto district curriculum guides and then give preference to texts in which objectives align well with district objectives. This rule is especially significant because the same district policy that instructs teachers to use curriculum guides dictates that textbooks should be used only as secondary resources in curriculum decision-making. At the level of formal policy, the district policy that subordinates texts to curriculum guides reasserts district authority over curricular content and pedagogy. In effect, it mitigates the state's capacity to directly affect content by systematically controlling the types of texts that make it onto the list of approved materials.

District priorities are also protected by district curriculum specialists who serve on committees to revise curriculum guides and select textbooks. They monitor committee procedure to ensure that teachers abide by rules designed to encourage the selection of texts supportive of district curriculum guides. Also, only teachers who volunteer serve on district textbook (and curriculum) committees, and these individuals are rarely compensated for such work. The teachers who volunteer for these committees usually represent those who are most active in their fields and committed to district policies--especially now, in District A, where district policy in math and science is moving toward the recommendations of national teachers' organizations that emphasize problem solving.

Whether state or district policies impact course content and instructional practice more cannot be answered solely by examining formal policies. Instead, we need to look closely at classroom practice to assess which if any formal policies affect what teachers ultimately do. This task will be addressed in School Case Studies S1 and S2.

Independent District Initiatives

In addition to endorsing or altering state policies, District A creates policies. These policies are important because they often stem from problems of special concern at the local level. Comparing local and state priorities provides an indication of how aggressively a district is likely to implement state policy. Districts may be distracted from state policy priorities when they expend discretionary resources on problems that rank low on the state's agenda.

Although state policy reflects concern with high dropout rates, District A has particularly severe problems in this area. In fact, shortly after EIA was passed, District A was declared an "impaired" school district, largely due to exceptionally high dropout and absenteeism rates. Since then the district as a whole has made great progress in both areas. One tool the district uses for reducing the dropout rate is special programs for at-risk students. Many campuses use the School-Within-A-School strategy to allocate special resources to students experiencing academic difficulty. Another program permits students who are not promoted at the end of eighth grade to go on to high school with their cohort while continuing eighth-grade course work in their first year of high school. Students who stay with the program are able to complete their high school requirements in the normal four years. Another district program provides adult education classes on evenings and weekends.

Students are not categorized as dropouts if they enroll immediately in the adult education program on failing in their senior year.

The district also invests substantially in magnet schools to stimulate desegregation. Special equipment is the norm for magnets, requiring high per capita student expenditures. Pouring money into a handful of magnets means fewer resources for others. In addition to receiving a disproportionate share of resources, magnets use special admissions criteria that promote "creaming"--a practice in which high achieving students across the district are removed from their regular schools and brought to the magnet campus. Recent research on desegregation suggests the need to look at the impact of creaming on the schools that lose their high achievers, in addition to looking at the experiences of the high achievers themselves (Hemmings, 1992). One possible unintended consequence of magnets is that schools giving up their high achievers will cease to have a "critical mass" of students who exemplify the ideal of achievement.

For the purposes of the present analysis, District A's magnet policy is important mainly in that it creates a tension between district and state policy. This tension stems from the fact that district magnets stress excellence (i.e., superior achievement), whether in academics, technical education, or the arts. District publicity promoting the advantages of magnet school instruction stands in sharp contrast to the state's emphasis on basic skills.

Summary of Key Policies in District A

District A has formal policies that act to support state policies, to modify them, and sometimes to channel the labor of teachers and financial resources into alternative areas. The district's large size and its administrative bureaucracy appear to encourage detailed specification of policies and enhance mechanisms for monitoring compliance. The case studies for schools S1 and S2 will examine some of the concrete effects of these policies.

Key Policies in District B

With 28,000 students, District B is less than two-thirds the size of District A but larger than the majority of state districts. District B has a racially and socioeconomically diverse student population, encompassing wealthy suburbs as well as rural schools.

Two features characterize policymaking in District B. First, district-level initiatives affecting curriculum are minimal. As the district assistant superintendent suggests, the lack of county-initiated policies can be attributed to the district's low ratio of administrators to students. Creating, implementing, enforcing, and evaluating elaborate policies require a large administrative staff. The district does not appear to have the capacity to routinely exceed the level of administrative activity required of them by the state. Second, in addition to having a limited capacity for policymaking and implementation--and possibly as a function of this limitation--District B also adheres closely to key state policies. The district's reliance on state policy will be apparent in the case study of school S3, as well as in the description of district policies given below.

District Endorsement of State Policy

District B makes no attempt to supersede state policy in most areas, nor does the district develop elaborate formal implementation procedures for most state requirements. For example, only in the last few years has the district begun producing course outlines that formalize key objectives. The assistant superintendent explained that the district has ruled out going beyond outlines and attempting to produce detailed, course-specific curriculum guides because of limited staff and resources. He also believes the state is about to embark on writing such guides. For this reason, he is content to wait and see what they come up with. He does not wish to duplicate state efforts or design district guides only to have them quickly superseded by state documents.

One set of policies District B has pursued aggressively is that pertaining to BSAP, including the SIRP program. The assistant superintendent reported these policies were most heavily emphasized when the state began to require the BSAP exit exam for graduation, because the initial test performance was very poor in some district schools, especially in its many rural schools. When BSAP was first given (in 1984-85), only 48% of students tested in District B met the state minimum standard on all subtests. Some schools were far below the district average.

The assistant superintendent reported that many administrators were startled by initial BSAP results. None of them wanted to be deemed "impaired" by the state, nor did they want large numbers of high school seniors to become ineligible for diplomas because they had not passed the BSAP exit exam. Furthermore, many of these administrators themselves thought BSAP scores in some schools were pathetic. For these reasons, the district moved quickly to impress on staff the importance of BSAP and related EIA policies.

District administrators and principals used several strategies to bolster basic skills instruction at the high school level. First, the district channelled its own funds as well as EIA money into remedial courses in math, reading, and writing. Second, they used workshops and staff meetings to stress the importance of BSAP objectives, concentrating especially on teachers of lower-level courses and general track students. Third, administrators stressed to teachers the tangible penalties and incentives the state had attached to basic skills performance. By embracing BSAP, the district ensured that teachers received consistent messages from all sides. Teachers realized they would have to devote more attention to basic skills if they wanted additional state dollars for their schools, bonuses for themselves, and the support of their immediate supervisors. Although this discussion emphasizes how teachers experienced policy changes related to BSAP, it is important to remember that students were also affected. BSAP pressured students to actually assimilate basic skills knowledge, at least some of which teachers had been presenting all along.

District Modification of State Policy

Despite the original enthusiasm of district administrators for BSAP, their support for the program is now declining. Examining why some administrators are beginning to see BSAP as less viable helps us understand why they supported it initially. Ironically, declining interest in BSAP may largely be a consequence of the program's own success. As noted above, only 48% of the students tested in District B passed all sections of BSAP when it was first incorporated into EIA in 1984-85. In 1991, however, 84% of the district's students met BSAP standards for their grade level. In some schools the success rate on BSAP now approaches 93%.

From the standpoint of district administrators, the BSAP exam loses much of its utility as student success approaches the 100% level. In the past, the assistant superintendent told us, he relied on the exam to determine which schools were doing particularly poorly in rudimentary instruction--the assumption being that, if they were failing to teach basic skills, then they must be generally ineffective. Now that practically all students pass, this administrator observed, the test no longer differentiates between individuals (or schools) within the population. Since he can no longer use test results to determine which schools are most in need of improvement and in which areas students are most lacking, the test has lost much of its utility for him.

This administrator's attitude suggests that his initial support for the BSAP program did not imply that he liked all aspects of the BSAP exam. Rather he saw BSAP as a tool for pressuring unusually poor schools into "producing" academic achievement. Improvement, however modest, was his objective. Now that many schools make similarly high scores on BSAP, this administrator, and others like him, are turning their attention to the actual content of BSAP. He believes that unlike before, when BSAP constituted a higher standard for schools to strive for, the exam is now beginning to constrain achievement. He suggested that instead of aiming for substantially higher scores, many schools now seek only to maintain current performance levels. He went on to say data show that

BSAP scores have reached a plateau in many district schools and argued that schools will lack a target for further improvement until BSAP is revised using higher standards.

State administrators reassessing BSAP content face at least two alternatives. One option would simply be to raise the score students need to achieve standard. A similar tack would be to create new items similar to those currently on the exam, but to increase their level of difficulty (e.g., ask students to calculate answers to nearest hundredth instead of nearest tenth). Either of these options might increase basic skills performance as these skills are currently formulated on BSAP. An alternative would be to make qualitative changes in the test, replacing the current items with ones that require students to perform fundamentally different intellectual tasks. The assistant superintendent in District B favors the last approach.

Although he feels BSAP was needed in 1984, the assistant superintendent now believes the very nature of "basic skills" must be reassessed. Now that most students are mastering the original BSAP, he perceives a tension between "basic skills" knowledge, as it is formulated on BSAP, and other kinds of knowledge that could legitimately be defined as "basic skills." The assistant superintendent's view on how BSAP content should be changed reflects the position taken by professional groups such as NCTM: redesign BSAP to emphasize problem-solving and higher order thinking skills. He is aware that the state is contemplating doing just that and supports such a change.

Important implications follow from the above discussion of District B responses to BSAP. First, we are reminded that local interpretations of state policies often evolve over time. As local conditions change, the potential effects of state policies on local institutions may be transformed. In the case of District B, the state BSAP program is perceived to have reached the end of its useful existence. As a short-term tool, BSAP was perceived to have many benefits. As a long-term strategy, it is believed to create a drag on the system.

One implication of this insight for policymaking is that district-level administrators may be in a better position than state policymakers to detect early on certain limitations of a state policy tool such as BSAP. District administrators quickly realize when they are investing a great deal of energy in policies that fail to provide them with the information they desire for assessing their schools, teachers, and students. Yet, the fact that an instrument such as BSAP lacks utility for some districts may be of little concern to state officials. State policymakers tend to aggregate state data and, in so doing, continue to perceive room for further improvement in achievement scores statewide. From the state's perspective, BSAP has done much to improve scores, and it would be premature to terminate the program until all schools reach and sustain a high level of basic skills achievement. It is not a major problem for state policymakers if some districts arrive at the goal sooner than others. It seems ironic that the state policy now in question--BSAP--has come to be seen as a potential drag on achievement precisely because it has already been highly successful in realizing its original goals. Now that schools in some districts are measuring up to the state standard for acceptable performance, local administrators are beginning to think more carefully about the tool the state has created for measuring performance.

We have focused here on BSAP because it is a key policy instrument in the district and the state. However, the insight that districts change their thinking about and endorsement of state policies over time, in conjunction with shifting perceptions of district needs and policy effects, is generally useful in analyzing diverging state and district policy perspectives. Furthermore, just as district administrators may diverge from state policymakers as a result of changing district needs, school principals and teachers may over time perceive their own interests to be converging with or diverging from those of district central administrators. For example, the state TIP program became highly divisive in many schools and therefore lost support at the district level. Whereas the district was once happy to allow schools to choose between the "campus" and "individual" TIP plans, the district decided, in 1990, that all schools would thereafter use the campus plan. Yet despite the fact that the district administration has decided the individual TIP plan is not working, some principals and teachers continue to support it.

Each time actors at one level of the system change their position on a policy, it potentially alters their relations with actors at other levels who also have a stake in the policy. In instances where the district administrators move toward or away from consensus with the state, we want to look at how the administrators' new stance affects the administration's relations with principals and teachers. These issues are revisited in the school case studies.

District Extension of State Policy

An area in which the district has gone noticeably beyond what is currently mandated by the state is that of teacher evaluation. The first step the district took, beginning in 1990, was to adopt a new evaluation program that is being promoted--though not required--by the state. The program, entitled Consensus Based Evaluation (CBE), is more extensive than any system previously used in the district. Under CBE, three evaluators conduct two classroom observations of every continuing teacher each third year; new teachers are evaluated in each of their first three years. The three evaluators then meet to compare observations and reach a common understanding about whether the teacher is "deficient," "competent," or "superior." Any teacher found to be deficient must improve by the end of the school year or be dismissed. As yet no teacher has been dismissed at S3 under this program.

Since the CBE program appears to have great potential to affect teacher practice, we need to consider precisely which aspects of practice the program is designed to monitor. CBE devotes little attention to content. Instead, CBE is based on ideas about effective classroom methods derived from the "effective schools" research of the 1970s and 1980s. Thus, even though the program may have some effect on math and science teachers, it does not appear that the adoption of CBE implies any special concern with course content in these disciplines.

Understanding district adoption of CBE needs to be tempered by recognition of two extenuating factors: (1) the program was chosen when the state was requiring all districts to establish a formal evaluation program of some type; and (2) district administrators adopted this program under the belief that the state might soon require CBE for all districts. Thus, the district's decision to adopt CBE does not alone demonstrate a clear intent to intensify teacher evaluation.

A stronger stance on teacher evaluation is evident in another policy instituted by the district in 1990. This policy requires all principals to conduct five informal observations daily. One of these observations must last 30 minutes, and all must be summarized in writing and submitted to the district superintendent. This practice could conceivably affect how teachers accommodate formal district policies in their classrooms and increase the ability of administrators to systematically enforce district policy. But irrespective of whether this new policy has an independent effect on teachers, by instituting this policy in conjunction with CBE, the district has committed substantial organizational resources to teacher evaluation.

The new emphasis on teacher evaluation represented a significant change at the district level. Previously there had been little formal evaluation, and administrators report having adopted the view that teachers are professionals who require autonomy to do their best work. Although the district now undertakes extensive formal evaluation, some individual administrators appear to have retained their previous belief in teachers as professionals.

The tensions between the new, formal evaluation policies and the old informal view may be too great to be accommodated in one coherent set of attitudes. The difficulties of maintaining teacher autonomy while conducting extensive teacher evaluation based on criteria defined by administrators are evident in comments made by the assistant superintendent. He discussed ways in which BSAP policies act to constrain teachers, as well as his attitude toward the proper impact of newly adopted district curriculum guides on teachers.

> The state department has been mostly regulatory. They tried to move from that, but it gets involved with politics--it's just a tough kind of thing. But in the four years I have been up here, [regulatory emphasis] has been almost exclusively in the instruction and content area--I don't want to get everybody marching to the same step. I don't think that is good. People need to be creative and use what initiatives they have and develop them, but there ought to be a base or a starting point and then everybody should include these things and go on from there. The catch statement I have used with the curriculum guides [the recently revised course outlines specifying key objectives for each course] has been, the only choice you have is that you could teach more than what is in there, but you don't have a choice to teach less.

These comments show that this administrator recognizes how restrictive state policies can suppress certain desirable teaching practices while seeking to maximize others. Not surprisingly, he believes the district has resisted this pitfall with its new curriculum guides by avoiding overspecification of the entire curriculum. Yet, his very sensitivity to the issue suggests that he recognizes the potential for district as well as state policies to constrain "good" practice. Our inquiry into classroom practice at S3 addressed the extent to which teachers perceived a tension between the traditional, informal attitudes of administrators and the district's recently adopted policies on teacher evaluation.

Independent District Initiatives

As in District A, problems receiving little attention from the state are of great concern to district administrators in District B. One problem District B has is attracting teachers to work in its rural schools. Administrators attribute teacher shortages to the fact that teachers are reluctant to live in the communities where these schools are located and do not want a long commute. Administrators also acknowledge the widespread belief that many of these schools have inadequate facilities and low-achieving, poorly motivated students. Shortages are especially chronic in high school math and science, in part because a statewide shortage in these subjects increases competition for teachers.

The district has responded to this problem by establishing a program to encourage teachers already working in the district to transfer to less desirable schools. The particulars of the district's teacher transfer program suggest that they place a high priority on the problem. For example, the district uses salary bonuses of $4,000 - $5,000 annually to entice teachers to move into the affected schools. The district's desire to find truly good instructors for these schools is evidenced by the fact that only teachers who receive a rating of "superior" on district evaluations are permitted to participate. This program demonstrates that District B, despite its small size, does have some capacity to identify and respond independently to local problems.

Summary of Key Policies in District B

District B often relies heavily on state leadership at the level of formal policy in lieu of initiating extensive policies of its own. The district seemed particularly attuned to state policy when the EIA came on line, although district commitment to particular EIA programs, such as BSAP, appears now to be declining. District disenchantment with BSAP appears related to the changed meaning of BSAP scores in the local context. High BSAP scores once represented a goal for improvement. Now, however, district administrators see further dedication to BSAP as a potential source of stagnation.

One area in which the district significantly exceeds state requirements is that of teacher evaluation. The district is also experimenting with a program to reduce severe shortages of math and science teachers in its rural high schools. This latter effort demonstrates the district's capacity to formulate substantial policy initiatives in cases where state policies fail to solve local problems.

An important result of the above comparison of state and district policy is the realization that district interpretation of state policy is a dynamic, evolving process. The fact that a district embraces a state program at one point in time--thereby underwriting state policy intent--does not guarantee that the district will continue to support the program indefinitely. In the same way that district administrators can depart from state policymakers in their assessment of how best to proceed, school administrators can diverge from administrators at one or both of these other levels. Case study S3 will examine how one school administrator operates within the state and district policy context described above, as well as how teachers adopt, adjust to, and resist measures initiated by policymakers at all levels.

Part III: District A's S1 High

District A faced three serious problems during the 1970s and early 1980s. First, due to declining enrollment, especially at the high school level, many schools were operating at less than half capacity. Second, facilities were in poor condition: the district had determined that it would be cheaper to replace than to renovate many schools. Third, the federal courts were pressuring the district to desegregate. The district attempted to alleviate all three problems by initiating a school consolidation program. It was this program that led to the creation of S1 High.

The new S1 stands on the same site that was once occupied by the original S1 High. Built in the 1920s, the old structure was razed in 1981 to make room for a new facility. When the new S1 opened in 1985, it combined students from S1's traditional attendance area with students from the attendance areas of two other schools. The other schools were subsequently demolished. Consolidating these schools enabled the district to reduce the number of facilities it operates, move more than 1000 students from obsolete facilities into a modern one, and combine one predominantly white, middle-class school with two predominantly African American, poor schools.

The new S1 is housed in a modern three-story building. It boasts courtyards for students, lounges and departmental offices for teachers, separate office suites for administrators, counselors, and attendance officers. There are computer labs, an auditorium, a large gymnasium, science classrooms with built-in lab areas, and a library stocked with the most current collection we encountered. Classrooms throughout the school are carpeted, air conditioned, and spacious. S1 is the only one of the three South Carolina RUC schools that does not use portable classroom units.

The school grounds are well kept, landscaped with trees and shrubs. Tennis courts, playing fields, and a large athletic stadium buffer the building from the surrounding neighborhood. Prior to 1985, S1's building was considered the eyesore of the community. Now the school is one of few recent additions to a neighborhood that is otherwise characterized by plain storefronts, homes, and apartments that have changed little in decades.

Students

Enrollment has declined steadily since the new S1 opened with just over 1300 students in 1985. In December, 1990, S1 had only 900 students in the main program, plus 100 students in special education. According to the principal, the same lack of parental confidence in public schools that forced the district to consolidate schools during the mid-1980s continued to drain students from district schools following consolidation. Furthermore, according to the principal and several teachers, white flight surged at S1 when the district consolidated a traditionally all white school with two predominately African American schools.

According to the principal, enrollment at S1 had finally stabilized in 1990; he believed modest gains were in the offing. The principal credited the state EIA with helping to turn things around for S1 and public schools generally during the latter half of the 1980s. He believed firmly that enrollment losses would have been even greater had the state not infused funds to refurbish facilities, raise teacher salaries, and improve instructional programs. Even with the implementation of the EIA in the mid-1980s, there had been considerable lag time before parental confidence in public schools rebounded.

The principal cited the closure of many private schools since EIA implementation as evidence that parents were returning to the public schools. The principal's assessment of enrollment trends for public and private schools is confirmed by a state education agency document reporting that enrollment in public schools rose from about 616,000 in 1984-85, to over 630,000 in 1987-88. Private school enrollment declined from over 51,000 to under 45,000 students during the same period (South Carolina Department of Education, December, 1988). These changes represent a decline of one percent (from 7.6% to 6.6%) in the proportion of students in private schools since the implementation of the EIA.

About 70% of S1's students are African American, and 30% are white. The state education agency, which divides schools into quintiles primarily according to student socioeconomic status, places S1 in the second lowest group. Over 60% of students at S1 meet federal requirements for free hot lunch. Students at S1 maintained an average daily student attendance rate of 93%.

The principal reported that the proportion of low-income students had risen since 1985. In an interview, the head counselor said that people often exaggerated the level of poverty and homogeneity among S1's students. Her view was that S1's students represented a range of backgrounds and that a substantial number of middle-class families remained in the community.

At the time of our fieldwork, parent involvement in the school seemed to be increasing. The principal noted that 180 parents had joined the school's Parent Teacher Student Association in 1991, whereas only 45 participated in 1990. The School Improvement Council, also composed partly of parents, met monthly during 1990-91 as part of a school-based management (SBM) initiative. Despite increased parental involvement, several teachers told us many parents were apathetic toward the school and education generally. A common complaint was that parents allowed children's jobs to interfere with school. The principal and counselor also cited student employment as a problem.

In Spring 1991, S1 had 378 freshmen, 184 sophomores, 162 juniors, and 173 seniors. Females accounted for only 45% (171) of the freshmen, but 53% (97) of the sophomores, 59% (96) of the juniors, and 57% (99) of the seniors in the school. The official dropout rate at S1, in 1989-90, was 7.6%. By the end of the first semester of 1990-91, 3.2 % (or 30) of the students who had started the year at S1 had officially withdrawn without enrolling elsewhere.

Many students at S1 fail to progress normally through the grade levels, partly because of the district policy that requires all students to pass area exams for certain courses. Students who fail an area exam are denied course credit and are ineligible for grade level promotion. Our data do not permit a distinction between students who are retained due to failure on an area exam and those who are retained for other reasons (e.g., frequent absenteeism or outright failure of courses). Anecdotal evidence suggests that failure on area exams and absenteeism are highly correlated at the level of the individual student. Also, males are much more likely than females to fail area exams. Grade nine students are most affected, because area exams are used primarily in lower level courses.

In 1989, S1's ninth graders scored at the 23rd percentile in the state in language and the 21st percentile in reading on the Comprehensive Test of Basic Skills (CTBS). On the math portion of the CTBS, freshmen scored at the 21st percentile. Eleventh graders scored at the state median in math and at the 38th and 47th percentiles in language and reading, respectively. Much of the gap between the ninth and eleventh grade may be accounted for by the high dropout rate among freshmen and sophomores. Many students who score low on the test in ninth grade leave school before their cohort sits for the CTBS again in eleventh grade.

S1 fares well on the state BSAP exam. In 1989, tenth graders passed at the rate of 86% in reading, 78% in writing, and 83% in math. This placed S1 at the state median for BSAP and above average for schools with student populations of comparable socioeconomic status. S1 scores substantially higher than S2 on the BSAP, even though the test data for S2 include the 120 students from the academic magnet school housed on campus.

S1 has increased enrollment in intermediate and advanced college track math courses such as Algebra II, Precalculus, and AP Calculus since implementation of the EIA. In science, CP (college prep) Chemistry has made a strong showing, maintaining steady enrollment despite a declining school population. The magnitude of enrollment increases is discussed in the sections on the math and science departments.

Faculty

S1 employs 65 teachers; 45 are female; 20 are African American, and the rest are white. There were 9 new teachers in 1990-91 (14 percent). Teachers have an average daily attendance rate of 96% and average more than 9 years of teaching experience. Teacher salaries are somewhat above the state median and near the district average. According to the principal, teachers perceived themselves to be somewhat underpaid because surrounding districts were among the wealthiest, highest paying in the state. Staff at S1 have never received bonuses from the state's Teacher Incentive Program.

Faculty morale at S1 seemed to be strained but improving. The principal had assumed leadership only one month before the start of the school year in which we collected data (1990-91). Teachers were very positive about the principal when we interviewed them during the first week of December. Faculty believed strongly that the principal was responding sincerely to their concerns. In contrast, faculty perceived a lack of leadership from central administrators. At the time of our fieldwork, the district was conducting a search to replace the previous superintendent who had resigned amid highly publicized conflicts with the school board. Teachers repeatedly criticized the school board for politicizing their activities and ignoring the needs of teachers and students.

Administration

S1 enjoys a relatively low student-to-administrator ratio of 224:1. The principal is one of three white male administrators at S1. The fourth administrator, also male, is African American.

While new to S1, the principal did have extensive experience in the district. After receiving his high school diploma at the "Old S1 High" and completing college, he returned to the district. Following many years as a history teacher and coach, he spent several years as an assistant principal in each of the two schools that were eventually merged with the original S1. As principal of S1, he supervises some of the same individuals with whom he previously taught.

The principal believed his background in the district strengthened his relationship with staff. He reported relying heavily on the SBM mechanism to communicate with faculty. He believed SBM gave teachers a meaningful role in decision making, though he also said he reserved veto power over faculty proposals.

When asked, the principal readily named three concrete changes that resulted from SBM during the first two months of his administration.

> Well one thing, we used to have a time clock. Anytime they [teachers] came to school they punched in and out and they felt like that was degrading, so we took it off. We don't do it anymore, and, you know, it's just a little thing, but it's something big to a group of teachers. We changed the schedules. We added an extra 2 to 3 minutes on instructional time [per class period], and it was basically their decision and we took a little of that time off of lunch. They felt that we had too much time at lunch--wasted time. . . . We cannot interrupt classes with announcements. We only make announcements during homeroom period.

Several teachers confirmed that these changes had been proposed by faculty and quickly adopted by the principal. The response of the target teacher for Precalculus to our queries about the role of SBM reflected a view voiced by others.

> The years we had it (school-based management) under the previous principal, it didn't work at all. It was a scapegoat for him to just say, "Well, this decision was made by school-based management." It seems to be working much, much better with [the new principal]; and he really does try to get input from the teachers on all major decisions.

> He is sensitive to the fact that, if he doesn't, we don't like it. We really expect good things from him and we seem to get them.

We interrogated further, asking whether there were some decisions that the principal alone makes.

> I'm on the SBM committee. He (the principal) tries to run everything by us. I mean, the few little things he has done without our information and without discussing it first were real minor. I really feel like it is a working organization.

The math chair reported that she was satisfied with SBM but went on to note that "the people who get things done [under SBM] are the same ones that were good at getting things done before." She felt SBM was an efficient way to institutionalize teacher involvement but did not believe it had an independent effect on school policy and practice.

Further discussion with the principal suggested that SBM's role in determining policy was highly ambiguous and possibly more symbolic than substantive. For example, the removal of the time clock from the teachers' mail room was promptly followed by the posting of a time sheet on which teachers were required to record their arrival and departure from school. Only the mechanism for monitoring teachers' activities had been altered. Also, we later learned that EIA regulations had already prohibited principals from interrupting classes with unnecessary public address system announcements. Thus, wittingly or unwittingly, teachers had used SBM not only to advocate for new policies but also to compel administrators to conform to existing state policy.

General support for the principal was especially evident among science faculty, as demonstrated by the department chair.

> The change in administration in the last year or so I think has improved things here at the school. I find I have a lot more input into decisions and I think all the teachers have a lot more input into decisions now.

Elsewhere, the science chair reported that not only did the principal communicate well with the staff as a whole, but that he maintained a good relationship with individual departments. Concrete examples of collaborative decision making between science faculty and the principal are presented in proceeding sections.

Our interviews indicated that the principal was willing to depart from district policy and traditional school practice when teachers felt strongly that such a step was required. For example, one math target teacher described how she had recently appealed to the principal for help with a bureaucratic rule affecting her AP Calculus course. According to the teacher, the problem began when six students whom she had recruited for AP Calculus were denied admission by counselors. According to district policy, counselors explained, the students' standardized test scores were too low. The teacher took her case to the principal, arguing that the students were sufficiently motivated to benefit from the class, irrespective of whether they might eventually pass the AP exam. The principal yielded; the students were enrolled.

The principal at S1 resembled others we interviewed in that he desired greater resources for the school. He lobbied the central office, though unsuccessfully, to have S1 selected as the site for an experimental district program for computerized instruction of writing skills. He reported initiating a new program in which S1 alumni from area businesses came to school weekly to tutor at-risk students. The principal was also exploring possible school-business partnerships. In short, he appeared to pursue the full range of strategies commonly used by principals to enhance organizational resources.

Math Department

The math department had one part-time and seven full-time teachers. The full-time teachers, all of whom were certified in math, conducted five classes per day, averaging about 23 students per class. The part-time instructor conducted two classes of General Math, but he was certified only in social studies. State regulation permits teachers to conduct up to two classes per day in subjects in which they are not certified, provided they have at least 12 credit hours of college course work in the subject.

In 1990-91, the math department conducted 37 classes daily under 13 different course titles. The mainstays of the math department (with course enrollment for 1990-91 shown in parentheses) were General Math I (182), Algebra I (122), Algebra II (112), Geometry (103), and Remedial Math I (106). No other math course enrolled more than 100 students.

In 1990-91, math classes averaged 23.25 students. The average class size in intermediate CP courses (i.e., CP Algebra I, CP Algebra II, and CP Geometry) was 26.1; in the three levels of General Math it was 25. CP and honors courses in Precalculus, Calculus, and Geometry averaged just 19, while remedial courses (for students who had already failed the math section of the tenth-grade BSAP) averaged 19.8 students. The comparison of enrollment by course types shows that courses serving the greatest number of students also tend to have the largest class sizes.

RUC target courses in math at S1 were Algebra II and Precalculus. Both courses had shown steady enrollment gains since implementation of the EIA: Algebra II had gone from 52 students in 1983-84 to 112 students in 1990-91; enrollment in Precalculus climbed from 22 in 1983-84 to 52 in 1990-91. Thus both target courses met our criteria for enrollment gains and reflected our emphasis on upper level courses in South Carolina.

Enrollment gains in Algebra II can be attributed mainly to increased graduation and college entrance requirements mandated in the EIA. However, increased enrollment in Precalculus appeared to be unrelated to the EIA. Although it would seem reasonable to expect that more students would advance to Precalculus as the number completing Algebra II rose, this "trickle-up" phenomenon did not occur at other South Carolina schools we examined during the site selection process. According to state officials, S1 posted the most dramatic increases in upper-level coursetaking in the state among low-income schools. Further inspection revealed that enrollment gains in mathematics in every school except S1 were limited to intermediate courses such as Geometry and Algebra II. Enrollment in the most advanced courses, such as Precalculus, actually declined.

To view a representative case, enrollment in Geometry at S2 jumped from 60 students in 1983-84 to 165 in 1989-90, while Algebra II enrollment climbed from 106 to 124. These gains were particularly impressive, considering that total enrollment in math courses at S2 fell from 1391 in 1983-84 to 1028 in 1990-91. During the same period, however, S2's enrollment in Precalculus fell from 51 to 11. As we note in the proceeding section, enrollment gains at S1 in advanced math courses such as Precalculus and AP Calculus appeared to stem mainly from the efforts of teacher to recruit students.

State Defined Minimum Program (DMP) requirements specify certain courses that schools must offer so that students may satisfy graduation and college entrance requirements. Such requirements often exhaust the course offering capacity of small departments, thereby eliminating electives and experimental courses.

The only new math course initiated at S1 in recent years was AP Computer Science. The course never came to fruition, due to insufficient enrollment. Further, the department dropped Introduction to Computer Science in 1989, despite sufficient enrollment. Math courses included in the state DMP were gaining enrollment and required more staff; Computer Science was not part of the DMP.

Departmental Organization and Operation

Departments were overseen by chairs who influenced decisions regarding teacher assignments, departmental budgets, and supplies. Chairs were also responsible for conveying information from administrators to teachers. The district compensated chairs by relieving them of homeroom duties (homeroom met 20 minutes daily). Chairs were also paid $20 annually for each teacher in their department.

The district policy on school decision making and authority states that chairs are directly accountable and subordinate to principals. However, the actual functioning of departments varies considerably because many policies are vague and there is little monitoring of policy implementation. Variation also occurs because some principals act in consultation with chairs, SBM committees, or individual teachers, while others use a top-down administrative approach.

With respect to issues such as the department's relationship with administration, professional interaction within the department, and the decision-making process, we found that S1's math department was more similar to departments at S2 than it was to its own science department. The math faculty at S1 was highly fractionated; individual teachers disagreed about what was best for the department, the school, and students. Some teachers thought the school pushed too many students into difficult courses; others thought the school needed to do more of that. Some teachers supported the use of highly prescriptive curriculum guides and the district policy on area exams; others rejected such things. Despite differing perspectives among math faculty, teachers rarely discussed curriculum at department meetings. The main exception occurred when the chair acted as a conduit to relay administrative strategies for aligning curricula with BSAP content.

Not only did the math chair, who was also the target teacher for Algebra II, lack consensus within her department, she also received little support from the principal. The principal volunteered to us that he hoped to replace the then-current chair with the woman who was the RUC target teacher for Precalculus. For her own part, the math chair appeared to have abandoned organizational practices that often enable chairs to preserve what little power they may possess. For example, relatively powerful chairs often cultivate their own authority by situating themselves between administrators and other teachers in information and decision-making networks. But, as evidenced by comments made in her interview, S1's math chair was not highly protective of her prerogatives in this area.

> The principal is always open to any teacher coming to see him and I always tell my math people, if they are not satisfied with talking to me, go straight to the principal. And a lot of them do, and that is fine.

There were other indications that the math chair was not closely aligned with administration and district policy. The other three department chairs we interviewed in the district stated unequivocally that it was important for teachers to abide by district curriculum guides. As chairs, they tried to set a good example by using the guides in their own classes. In contrast, S1's math chair said many curriculum guides were poorly designed or obsolete. She relied primarily on textbooks to determine course content and sequencing.

Math teachers tended to pursue objectives individually rather than work through the department. Such activity is illustrated by the teacher who convinced the principal to suspend standard placement criteria for AP Calculus in order to admit students with low test scores. At a time when many teachers were complaining that too many students were academically "in over their heads," the Precalculus teacher was taking advantage of direct access to the principal to increase student access to advanced courses.

Science Department

S1's five full-time and two part-time science teachers conducted 29 classes daily in 10 courses. The part-time teachers, who were certified in physical education, each taught two classes of General Biology daily. Full-time teachers each taught five classes to between 112 and 147 students daily. Offerings included general, college prep (CP), and honors sections of Physical Science and Biology I; CP and honors Chemistry; and CP courses in Physics and Environmental Studies. RUC target courses in science were CP Chemistry I and CP Physical Science.

Science course enrollment at S1 changed little between 1983 and 1991, even though the EIA increased the graduation requirement for science from one credit to two. CP Chemistry I, the only course that held its own in the face of an overall decline in school enrollment, went from 55 to 89 students during this period. Post-EIA highs for enrollment in CP Chemistry I came in 1985-86 (108 students) and 1987-88 (103 students). CP Physical Science actually lost enrollment but was included in the sample because, with 295 students in 1990-91, it had the highest enrollment of any science course at S1. We also wanted to compare Physical Science in South Carolina with Physical Science in other states.

Coursetaking trends in math and science at S1 were moving in opposite directions, even though the EIA had raised the graduation requirement by one credit in both subjects. There are two state policies that may partly account for the difference between the two subjects. The first policy is one that allows vocational students to substitute a vocational course for a science course; no exceptions are made to the math requirement. The second is a policy that de-emphasizes science by excluding it from state mandated standardized tests such as the grade 10 BSAP and the Stanford-8.

Although these state policies may undermine science coursetaking, the policies applied to all schools, and the general statewide trend in science was toward increased coursetaking. Science coursetaking statewide had risen by more than one-half year since EIA implementation. Several of the low-income schools we looked at during site selection posted impressive enrollment gains in intermediate science courses during the period in question. This suggests that sluggish coursetaking in science at S1 stemmed mainly from school policy.

Three other trends we noted suggested that the science department was moving away from rather than toward increased academic rigor for all students. First, since 1983-84, S1 had dropped courses in Experimental Science, Marine Science, and Biology II. These courses had been taken mainly by college-prep students as an elective in their senior year and were considered advanced courses by instructors. The department had also made preparations to introduce courses in Principles of Technology (described as "hands-on physics that requires little math") and General Science in

1991-92. The new physics course would permit college-prep students to fulfill the upper-level lab science requirement without taking traditional physics (which requires advanced math); General Science would enable general track students to circumvent Biology, thus making general track Physical Science (taken in ninth grade) perhaps the most rigorous science course they would encounter.

Another change in school practice advocated by science teachers was the use of more stringent placement criteria for college-prep courses. The rationale for this was articulated by the science chair.

> We have 5 CP Biologies and 3 General Biologies, and it should be the opposite. There should be 3 CP Biologies and 5 General Biologies, given the level of our students. And it starts from eighth grade. They get tracked wrong in the eighth grade and they have these stupendous dreams of going to college--the mother can't read, the father can't read--and, you know, there is no way, unless things change dramatically, that they are going to get into college. And they keep getting tracked into the wrong [courses]. And we're working as hard as we can, especially this year, to reverse those numbers [i.e., to have 3 CP Biologies and 5 General Biologies]. . . .

Directing more students into the general track was expected to bolster academic rigor in college-prep science courses by eliminating the least capable students from CP classes. Changing the placement system was also intended to "help" borderline students by relieving them of the pressure attributed to being in courses for which they were not academically prepared. The decision to increase low-level course offerings was organizationally complimentary to the decision to increase placement criteria for college-prep courses. As the department curtailed access to upper-level courses, they planned to introduce new low-level courses so that students would still be able to satisfy state graduation requirements.

Third, we noted disparities in class size between tracks. General track science classes averaged 30 students, whereas CP and honors science classes averaged only 25 and 20 students respectively. When asked about this, the principal readily acknowledged that classes in general track science were unacceptably large, adding that he intended to rectify the problem in the next school year. He did not say whether he would do this by allocating greater resources to science or by making the placement criteria for CP and honors science courses even more liberal than they were already.

Our data suggest the science faculty itself was instrumental in suppressing total enrollment in science and in college-prep science in particular, in bestowing disproportionately high levels of resources on CP classes, and in resurrecting basic courses. Below we discuss how science faculty operated within the organization and policy context to accomplish this. In Distinctive School Practices, we explore school, district, and state policies that may have encouraged the faculty to respond defensively to pressures in their environment rather than to promote rigorous content for all students.

Departmental Organization and Operation

In contrast to the math department, the science faculty was characterized by high levels of consensus. The department chair always used the collective "we" when speaking about science faculty. Like the science chair, the principal and the two science target teachers emphasized how well science faculty worked together.

Science faculty often discussed professional and organizational questions that had a direct bearing on course content, pedagogy, and other matters affecting instructional delivery. When asked to describe topics addressed at the most recent department meeting, the chair said they had prepared for an upcoming visit by a team of district evaluators, discussed changes in the Physical Science area exam, considered the merits of introducing an area exam for Biology, and planned for the district Science Fair.

In previous meetings the department reportedly made decisions on new courses, student placement criteria, expenditure of departmental funds, and teacher course assignments. A new departmental policy on teacher assignments emerged from departmental discussion of high rates of teacher turnover among beginning teachers. Examining the problem, the group decided that the traditional practice of allowing senior teachers to have first choice of courses was problematic, because it meant junior teachers were left primarily with general track and remedial courses. General track students were viewed as the most difficult to manage and least interesting to teach. The department decided to redistribute assignments in the next school year (1991-92), giving all teachers some desirable courses.

The science chair referred to other science faculty as "my teachers" and felt it was his job to represent their interests. District policy, which he considered to fluctuate between irrelevant and inane, was secondary. With the principal, however, the science chair sought a strong relationship. He believed the principal's support was necessary for the department to change student placement practices and course sequences. In reference to decreasing CP courses and increasing general courses, the chair said:

> [The principal] would encourage us to get it reversed like that because [the principal] understands the real level of our students, and he wants those students to do well in school. He doesn't want them to be frustrated in a CP course they shouldn't be in and fail it and have to repeat it or waste their time and drop back a level the next year. I don't know about further than [the principal]. Frankly, I don't bother myself with what they think. If what they think ever gets to me it goes through [the principal] anyway. So I don't care about beyond [the principal's] level.

The chair viewed the principal as someone who might attenuate the impact of unfriendly policies and outside regulatory agencies and thus preserve the department's ability to respond to locally perceived (and teacher identified) needs.

S1's science teachers used another strategy to influence curricular policy. More than math teachers, science faculty volunteered to serve on district curriculum committees. The target teacher for CP Physical Science had labored extensively without remuneration on the committee to design the Physical Science area exam. The science chair said the district was also considering forming a committee to construct an area exam for Biology. He said he would make sure he was placed on any such committee so that he could influence the content of the exam, thereby tempering its impact on his own teaching.

Instructional Resources

Textbooks were free and readily available, and students were allowed to take them home to study. However, departments did augment their supply and equipment funds by charging student fees. The principal said departments typically raise about $300 in fees. In math, students paid $2 per course. The science department collected $4 per student because of the high cost of lab supplies. The science department also received $500 in school funds in 1990-91, more than any other academic department in the school. The department chair mentioned that school funds are sometimes insufficient and that some teachers spend substantial amounts of their own money on supplies.

Science lab facilities at S1 were the best we saw in South Carolina. All science classrooms had lab stations, complete with propane lines. One lab was more fully equipped for experiments, although certain standard lab procedures could not be conducted because the lab lacked windows and vents. Teachers reported that because all classes shared the main lab it was sometimes impossible to get into the lab at the appropriate time.

The target teacher for Chemistry found it difficult to conform to the state and district policy requiring science teachers to devote 20% of class time to labs. He said that doing a thorough job on labs often meant spending less time on other material in the text. In this regard he criticized the course's textbook publisher for exaggerating the amount of lab work that could realistically be done by allowing one class period for labs that actually required two or three periods. The pressure he felt to cover as much material as possible outweighed the requirements of state and district policy.

Of all the science teachers in the RUC sample, the S1 Chemistry target teacher relied most heavily on lab demonstrations to reduce the tension between broad content coverage and in-depth understanding. He got the most out of demonstrations by using a closed-circuit television camera and monitors; students watched comfortably from their seats as the teacher efficiently presented "experiments." The video equipment had been supplied directly to the teacher by the district, not purchased from school operating funds. This teacher was the only one in the RUC sample who used video equipment for instruction.

It is not possible to determine whether the use of video technology increased student understanding of demonstrations, or whether the special equipment enabled the Chemistry teacher to give more demonstrations than he otherwise would have. However, he did devote more than twice as much time as his peers to demonstrations. Science teachers for the entire sample spent an average of 8 percent of their instructional time on demonstrations. For the Chemistry target teacher, the figure was 17 percent: a sample high for science teachers.

The Precalculus teacher sometimes took students to the computer lab for demonstrations. She did this less frequently than she would have liked because the lab was in a distant part of the building. Getting back and forth with large groups of students took too much time out of the class period. This teacher also wished she had enough graphing calculators for all her students, but she was thankful she at least had one that displayed images on the overhead for classroom demonstrations.

The math department chair said that students in her Algebra II classes were required to purchase their own calculators for use on daily work as well as tests. She compensated for this expense by not collecting a student fee. Another problem she noted was that teachers did not have sufficient access to photocopiers.

The principal noted two ways in which the resource picture at S1 may have differed from that of other schools. On the positive side, he felt the school benefitted from contact with faculty from nearby colleges. College faculty provided information on curricular materials and occasionally visited the school to demonstrate new activities to students and teachers. On the negative side, he said the school was not in a good position to get the full benefit of a district policy that permits district schools to use receipts from athletic events and vending machines to pay for School Improvement Council initiatives. Large or wealthy schools received more money from this source than small poor ones. S1 was neither large or wealthy. The principal mentioned that he had just used money from the supply fund to pay for special teacher workshops on assertive discipline arranged in response to concerns of the School Improvement Council. In some schools, such expenses are covered with vending and athletic receipts.

Math and Science Curricular Control

Textbooks and Curriculum Guides

As noted previously, the school is required to use state-approved district-adopted textbooks. The district adopts different textbooks for general track and college-prep track levels of the same subject (e.g., a different text is used for General Physical Science and CP Physical Science). The state supplies textbooks free of charge. However, students at S1 were not issued textbooks until they paid a $4 school activity fee and applicable fees for individual classes.

S1's district has curriculum guides for all levels of all courses and teachers are required to follow them. Following the guides usually means skipping around in the textbook, because the scope and sequence for guides often depart from that of the adopted text.

The target teacher for Algebra II said she had served on the committee to select the Algebra II text and liked the text very much. She told us she followed the text sequentially, omitting some sections at her own discretion. She also said the district curriculum guide for the course was poorly conceptualized and that she did not abide by it. Her log data reflect her reliance on the text and dismissal of the sequence prescribed by the curriculum guide.

The target teacher for Precalculus felt she had high control over the content of her course. According to the target teacher, the district had approved three different textbooks for Precalculus. Each text was written at a different level; the most difficult had been designated as the text for Honors Precalculus. As the sole teacher of Precalculus at S1, she had made an independent decision to order the two lower level texts. She used the more difficult of the two for the Honors Precalculus course, and the simpler one for CP Precalculus; she omitted entirely the text adopted by the district for Honors Precalculus.

The department chair for science said that most teachers skip sections of their science textbooks because texts include too much material to be covered thoroughly in a single course. The Chemistry target teacher said different texts were used for CP Chemistry and Honors Chemistry. As one who had served on the district textbook selection committee for Chemistry, he said the Honors text contained more advanced vocabulary and resembled traditional college chemistry texts. The CP text used only "basic vocabulary and less jargon," he said. The CP text was intended for students reading at one grade level below those using the Honors text.

The science chair was the only one of four chairs interviewed at S1 and S2 who reported regularly reviewing teachers' lesson plans to insure that they conformed to district curriculum policy. The Chemistry target teacher said he jumped around in the chemistry text to conform to the sequence of topics in the district guide. The target teacher for CP Physical Science also said she followed the district curriculum guide, even though it was organized very differently from the text. Below we note that she felt pressured to conform closely to the Physical Science guide because of district plans to pilot the new Physical Science area exam with her students at the end of the year. Log data support the self-reports of the Chemistry and CP Physical Science target teachers that they were following district guides.

State and District Tests

Target teachers at S1 reported that target classes were little affected by the state BSAP exam. Target courses in math at S1 were too advanced to emphasize basic skills content, and the tenth-grade BSAP did not include science. The math chair noted that the BSAP did affect content in lower level math courses such as Remedial Math, General Math, and Algebra I. According to the chair, teachers in these courses did not have strong objections to the test per se, though many resented the amount of paperwork the state required to document students' progress on BSAP objectives. For all students who had yet to pass the BSAP exit exam teachers were required to keep a card for recording each BSAP objective on which instruction was provided.

Some teachers at S1 were more concerned with district area exams than with the state BSAP. District area exams tested course content more systematically than the BSAP because they were based directly on course-by-course district curriculum guides. District area exams also placed greater emphasis on problem solving and application, thereby resulting in a higher failure rate than for the BSAP.

The target teacher for CP Physical Science related concerns about the district's decision to pilot the new Physical Science Area Exam with her classes at the end of the year. She felt overwhelmed trying to cover all the material in the curriculum guide. When interviewed in March, she had only recently completed the half of the textbook devoted to chemistry. This meant she would have only half as much class time to cover the half of the text on physics. She attributed her slow pace to the fact that the district required Physical Science for all ninth graders and that many were placed in the college-prep classes even though they lacked necessary skills.

> What has happened to me is that it has been fairly difficult to cover [the material]. This is hard material, this is not easy stuff. And every child is in here, just about. And there are some children, you know, and it is always the case where you have some kids who are not necessarily ready for college-prep material, and they have difficulties adding and subtracting positive and negative numbers, so they have a difficult time with some of this material.

She also predicted that it would be problematic for the district committee designing the test to select specific content for the exam. The committee's work was to be guided by the district's test blueprint (see Part II). The target teacher for CP Physical science believed that the student failure rate for the area exam would hinge on how the test design committee operationalized difficult item types such as application, analysis, and synthesis. She was struggling simply to cover all the material; if she had to take extra class time to go into great depth on many concepts or objectives, she felt she would not have enough time to teach all the tested objectives.

The science department chair said he would welcome an area exam for his Biology course, but only if he were to serve on the test design committee. As noted earlier, there was considerable evidence that he and other teachers at S1 frequently achieved what they considered satisfactory influence on curriculum policy by volunteering for district committees.

It is interesting to note similarities and differences between the principal's and teachers' view of district area exams. The principal responded to a question about the "pros and cons" of the exams.

> The pro is it is a measuring tool, and the exams are basically set up at a minimum standard. You've got to score at a certain level to receive credit. I don't think they're too difficult, but one drawback that I see is you get teachers that end up teaching strictly to that test, and it takes a little bit of the creativity away from the teacher. You know, "Well, today I am going to teach this," and then she sees a need to change and she won't change because she is teaching to those objectives. And she is going to put in so much time on each objective, and then she is going to have time lines. And I see a negative there. You know, "If I don't get there by such and such a date, I will not have taught that objective at all and it's going to be on that exam. So I'm going to skip this even though the kids don't know it, because they need to get a taste of this [other material]."

For the principal, the way test results were utilized for accountability determined whether the exams played a positive or negative role. He saw no problem with using the tests for student accountability;

he felt it was legitimate, albeit potentially divisive, for the exams to be used for teacher accountability; he believed the tests were not a valid measure of school effectiveness. He was not explicit about the logic according to which students and teachers but not principals could legitimately be held accountable for achievement test scores.

The math chair believed the area exams were not a valid basis for student and teacher accountability.

> This really concerns us with these county [district] exams. . . . we could have had a class of students that came in real behind, and we had to pull them out. And maybe they learned a lot in our class, but they still could have failed that exam. But that doesn't necessarily mean it is a reflection on my teaching ability. I mean I could have taught my heart out, the kids could have learned their hearts out, they just started way back, and so on.

This teacher expressed no concerns about the content of district exams.

The counselor felt that she already devoted too much time to test administration and that expanding district testing would prevent counselors from performing other important functions. Although counselors are not involved in the actual administration of district area exams, they are responsible for test security, distribution, and collection. The counselor did note, however, that her own review of test scores revealed that student performance on problem solving and application tasks in math had improved substantially following the introduction of area exams in General Math I and Algebra I. She could think of no possible explanation for this other than that the exams had caused teachers and students to concentrate more carefully on tested content.

Professional Development and Evaluation

Curricular content receives almost no attention on the district prescribed TAP instrument. The math chair reported that the previous principal had used standardized test results to determine whether teachers were covering district objectives and sometimes questioned teachers of particularly low achieving classes about test scores; low test scores thus seem to have attracted that principal's scrutiny but were not directly incorporated in teacher evaluations. The science chair said teachers never received feedback from administrators regarding content. This is probably due to the fact that administrators lack standardized test data for science.

The principal characterized his attitude on teacher evaluation.

> We try to stay out of the way of our teachers that are doing a good job. We'll go in from time to time to support them and give them some positive feedback, but what we're trying to do is work with those that need some help.

The principal said he had initiated "walk-through observations" to monitor teachers that he thought needed help. None of the RUC target teachers felt they were on the principal's list of teachers who needed help. Most teachers did not express strong feelings about the evaluation system. They did not believe the Teacher Assessment Program was particularly beneficial or valid, nor did they feel evaluations were likely to have serious consequences.

Two teachers raised specific objections to the evaluation program. The target teacher for Chemistry said that he resented being evaluated by administrators who had no training in his subject area. The Precalculus target teacher presented more extensive criticisms. She saw TAP as part of a general trend toward excessive, arbitrary regulation of teachers.

> The added days, the pressure, the fact that you never feel professional because there is always somebody saying, "Look at these test scores," or "Remediate these students." I really am under pressure. I've got these two students that I've got to remediate while I'm teaching the Trig. I don't know how to do that. And then, over the last few years, all this emphasis on formal evaluation of teachers. Every three years you have to be evaluated. Every three years you have to jump through these fifty-two hoops. And I don't understand why they can't just come in on an informal basis, more times, and see that, yes, over five visits you are doing all of these things. Why you have to cram fifty-two things into one period, just to show that you can do it: I want out. I mean, that is why I am teaching (part time) at the college level, because I want out. I'm going to teach at the college level. I am tired of all these things that I have to do to show that I am a good teacher.

S1's district complies with the state requirement to provide teachers with ten inservice days per year. Five days may be teacher work days; the rest are for planned workshops and classes. In 1990-91, S1 target teachers attended workshops on the following topics: methods for implementing the state BSAP program, coordination of district curriculum guides with texts, introduction to the NCTM *Curriculum and Evaluation Standards*, AP calculus curriculum, graphing calculators, effective teaching for at-risk students, lab activities for chemistry teachers, Science Fair ideas, and a math enrichment workshop. Teachers reported that most workshops emphasized pedagogy or implementation of state or district policies. Most teachers said they would prefer greater emphasis on content.

As with the evaluation system, few teachers had strong reactions to the inservice program. The Chemistry target teacher thought workshops were a waste of time. He estimated that for every hour devoted to substantive activity in a workshop or inservice, three hours were spent on logistical matters, including transportation. The Precalculus target teacher was enthusiastic about a math enrichment workshop she had attended and said she used numerous activities from that workshop in her classes.

Teachers were more positive about the time and energy they invested in continuing education courses. Several teachers valued courses they had taken to satisfy a state requirement that teachers earn six continuing education credits every five years. They also liked the fact that the state reimbursed the cost of tuition for continuing education courses. The state education agency used federal Eisenhower money in addition to state funds to contract colleges and universities to provide content-oriented math and science classes for teachers.

Other Curricular Influences

All teachers were asked to assess the relative impact of different policies on their daily work, focusing especially on classroom practice. The Algebra II target teacher said that the then new NCTM *Standards* were exerting greater influence on her math courses than the state's EIA initiative. She cited increased use of manipulatives and calculators since the introduction of the NCTM

Standards as evidence that the *Standards* were having concrete influence. The Precalculus target teacher, who was active in the state mathematics teachers' association, also stated that the *Standards* were influencing her courses.

It was significant that the NCTM Standards were already affecting course content and pedagogy because there had not yet been time to revise many district guides and textbooks to reflect the *Standards*. It appeared that at least some aspects of the *Standards* had been disseminated rapidly by NCTM and quickly incorporated into state and district inservice programs by central administrators. The immediate integration of the *Standards* into continuing education courses in mathematics (often funded through the Eisenhower program) may also have accelerated the speed with which the *Standards* came to teachers' attention. In any case, math teachers in S1 appeared to be getting significant exposure to the NCTM initiative even though conventional tools of curricular control (i.e., textbooks and tests) had not yet been revamped.

Course Sequences in Math and Science

The district recommends standard course sequences for each track (see Part II). S1's head counselor said students are encouraged to follow district sequences. She said general track students usually stop after three years of General Math, although some seniors take Business Math and a small number enroll in Algebra I. In science, general track students typically stop after General Physical Science and General Biology. The typical college-prep program for science was CP Physical Science, CP Biology, and CP Chemistry. College-prep students who took four years of science were most likely to take CP Physics, also. In 1990-91, 17% of the seniors at S1 enrolled in CP Physics.

Neither the school nor district collected systematic data on the distribution of students by track. S1's counselor estimated that about 35% of the school's graduates completed the college track, 35% opted for the vocational program, and 30% followed the general track.

Track placement profoundly affects students' postsecondary schooling options. Only students who complete the college-prep or honors program receive the college-preparatory diploma needed for admission to the University of South Carolina. Track placement also affects students' postsecondary options, because student class rankings are weighted according to course level. For example, students who earn an A in Remedial Math receive 1 point; in General Math I, 2 points; in CP Algebra, 3 points; in Honors Algebra I, 4 points; and in AP courses, 5 points. Thus, students who wait one or two years to enroll in college-prep courses are disadvantaged in competing for admission to those colleges that use class rank as a selection criterion.

It was not possible to determine how many qualified sophomores or juniors might have been discouraged from transferring into the college-prep track because their class rank was already unsalvageable. S1's head counselor said that five students transferred from the general to college track by taking extra classes in summer school in 1990. It is noteworthy that this occurred at all; district policy stipulates that students are only to attend summer school to repeat courses that they had attempted but failed. The school's willingness to allow some students to use summer school to take CP courses to catch up with classmates indicates that the school is open to facilitating upward track mobility, district policy on summer school coursetaking notwithstanding.

Course Selection Process

The course selection process begins in the middle school, where counselors rely primarily on teacher recommendations to select courses for prospective ninth graders. Parents may override counselors' selections, but those who do so must be prepared to meet with counselors and do extra paperwork. Teacher recommendations continue to play a central role in student placement throughout high school. It is rare for students to enroll in courses above the level recommended by teachers.

The student-to-counselor ratio at S1 was about 350:1. The head counselor said students typically met individually with counselors once annually. Students also attend two or three group counseling sessions per year. Group counseling is used to disseminate information regarding course selection and vocational and postsecondary options. Teachers are expected to augment counselors' information and answer students' questions about course selection.

Course Selection Criteria

S1's criteria for course selection and track placement were being reassessed by faculty and administrators in 1990-91. Basic changes appeared imminent in tracking practices, particularly in science. Some background on state and district policy since the mid-1980s is necessary to understand the changes being advocated by many teachers at S1 at the time of our study.

The freshman class of 1984 was the first to be subjected to the EIA high school graduation and college admission requirements. In 1985-86, enrollment in advanced math and science courses at S1 (e.g., Algebra II, Precalculus, Chemistry, and Physics) jumped up. At S2, the other school we studied in District A, the same courses posted similar enrollment gains at the same point in time. Although it seems likely that the state's decision to increase requirements contributed to enrollment gains in CP courses at S1, there were additional factors. According to S1's principal, head counselor, and teachers, the district's central administration liberalized course placement criteria soon after 1984. In compliance with district instructions, counselors began to reduce the role of test scores in student placement and emphasize teacher recommendations. Simultaneously teachers were told to encourage students to attempt college-prep courses. Most interviewees at S1 volunteered the hypothesis that increased state requirements for the college-prep diploma would have resulted in decreased enrollment in CP courses had the district not simultaneously lowered placement criteria.

Teachers believed the school would need to do one of two things to protect the academic integrity of CP courses in the future: tolerate rising failure rates for CP students, or reinstate stringent placement criteria, thereby reducing the proportion of students taking CP courses. We have already quoted at length the science chair's rationale for reducing the proportion of students in the CP track. His assessment of current tracking practices and anticipated policy changes for 1991-92 were echoed almost to the word by target teachers for Chemistry, CP Physical Science, and Algebra II.

The head counselor also said that she and her staff had given up on the district policy to push as many students as possible into CP courses. By the time of our study, counselors had returned to suppressing CP track enrollment.

> [More students transfer] from college placement to general because now, you start off with, like in the ninth grade, every child that comes here, a lot of them, not everyone, but I'll say fifty percent of them, figure, you know, they're going to college. So, what we try to do also is advise students that college is not for everybody. I mean, you know, it's good if that's where you want to go, but that doesn't mean that's the only place you have to go. There are a lot of kids that come in with no concept that there are other jobs out there that they could go into without a four-year college degree. So, we try to let them see what some of the other jobs and stuff are. Introduce them to some technical schools that they could get into and get jobs. So, because of the enlightenment, I think that's why it decreases from 50 percent to 35 percent.

Thus, counselors' attitudes were likely to facilitate rather than impede teachers' efforts to reduce CP track enrollment.

Distinctive School Practices

S1 is a school caught in crosscurrents of state and district policy, first listing toward one initiative, then toward another. Teachers as well as administrators appear quick to comprehend which policies are likely to affect them directly and substantially and which may be ignored. Then, given their individual understanding of the purposes of teaching and schooling, and the community and organizational context in which they work, teachers act to maximize the benefits and minimize the burdens of salient policies. Sometimes teachers focus on the advantages and disadvantages of policies as they affect students. Other times teachers concentrate mainly on the effects of policies on the quality of their own work life.

Even though S1 is located in a district that has curriculum policies among the most prescriptive in all of South Carolina, a state that is itself recognized for strong and comprehensive curriculum control policies, teachers and administrators in S1 maintained a broad range of influence over classroom practice. School level control of curriculum policy may have been enhanced by the existence of partially contradictory district policies. For example, the district policy to deny course credit to students who fail area exams worked primarily against the district directive to encourage as many students as possible to pursue college-prep coursework. Teachers desiring to reduce enrollment in college-prep courses did not have to defend their actions against the district policy to increase CP track enrollment. Rather, they could depict their decisions as constructive strategies for minimizing student failure on district area exams. In effect, contradictory policies allowed teachers to preserve their own prerogatives and power over instructional delivery by playing off one policy against the other.

The science faculty's ability to reach consensus and secure the principal's support for decreasing college-prep enrollment enabled them to shape the concrete impact of state and district policy on the school, including their own classrooms. The fact that the counselors and some math teachers, and perhaps teachers in other departments as well, agreed with the science department's plan appeared to have enabled rapid transformation of S1 from a school advocating college-prep courses to one promoting general track and vocational curricula. The implementation of SBM also appeared to facilitate the change. Teachers were able to use SBM to leverage school level decisions that were in tension with, if not contrary to, district policies such as the one to place more students in CP courses.

As S1 considered the important decision to retreat from a college-prep emphasis, state policy was never mentioned or perceived to be relevant by those advocating the change. Although the state education agency literature touted the importance of college preparation, the main thrust of the EIA and state expenditures during the 1980s targeted students on the low end of the achievement scale.

At S1, the math target teacher who was fighting to boost enrollment in her Precalculus course provides an interesting counterpoint to the science faculty. Like the science faculty, the Precalculus teacher appeared to be selectively utilizing some policies and minimizing the importance of others in order to garner legitimacy for steering her own work life and course curricula. At the same time that science teachers and some math faculty withdrew active support for the district policy of increased college-prep enrollment and turned their concerns toward getting students to pass area exams, the Precalculus target teacher continued to promote district policies oriented to including more students in CP courses. Although the substance of her objectives departed from that of her colleagues, her strategy was the same: rather than trying to resolve conflicts between various policies or to clarify ambiguous ones, she merely identified and emphasized the policies most conducive to her own aims as a teacher.

It should be noted that the Precalculus target teacher was not perceived by others to be a typical teacher. As an active member of the state mathematics teachers association, a part-time community college math instructor, and S1's advanced math teacher, she was considered to be the quintessential professional teacher. Perhaps more junior or less well-established teachers would have been more reluctant to depart from the views of their peers. This teacher's case is nonetheless instructive because it illustrates how different teachers in the same school or department may exploit inconsistent or ambiguous district or state policies to fashion the terms under which they deliver classroom instruction.

Although the Precalculus target teacher's enthusiasm for recruiting students to college-prep courses far surpassed that of other math faculty, other math teachers also contrasted with science faculty. Unlike science teachers, math faculty did not seem intent on convincing us of the limited abilities of their students, nor had they aligned themselves consistently or strongly with the science department's campaign to revamp the school's tracking system.

Strong regulation and monitoring of mathematics as a subject, compared to science, may partly explain the reluctance of S1's math teachers to join the science faculty in their attempt to circumvent district policy on tracking. Math is tested on the state BSAP high school exit exam, the CTBS, and the Stanford-8. For students in grades nine and ten, math teachers must keep an extra set of records to document instructional coverage of state-tested objectives. When S1's district piloted and implemented area exams, General Math and Algebra I were the first courses affected. In fact, district and state testing specialists frequently mentioned that math is almost always used as the proving ground for new standardized tests because there is a high degree of consensus about important math content, and math tests are thought to be less susceptible to measurement and scoring problems. Perhaps math teachers are so accustomed to regulation from principals, districts, and states, and to the constraints of standardized tests, that they are less inclined to exploit the flexibility that does exist in school organizations.

Our interest in exploring why S1 was moving away from academic rigor for all students led us to compare the school with S2, which also serves predominantly minority students and is governed by the same state and district policies as S1. As we will see below, S2's math and science faculty, as well as the counseling staff and principal, all aggressively supported enrolling as many students as possible in college-prep courses. Furthermore, enrollment in Algebra II, Geometry, and Chemistry had risen sharply following EIA implementation. Growth in college-prep course enrollment at S2 was not reversed by the implementation of district area exams, nor was there any sign that faculty were anything but solidly committed to the school's emphasis on college-prep curricula.

The only difference we noted that could have accounted for the different perspectives encountered at S1 and S2 was the racial composition of the faculty and administration. At S1, where only 31% of the teachers were African American, the principal, the entire math and the entire science faculty were Caucasian. At S2, 59% of the teachers were African American, as was the principal. Three of the four target teachers, the math and science department chairs, and the head counselor were African American. Faculty and administrators at S2 seemed personally attuned to students and the community, adamant that students could succeed academically, and emphatic that it was imperative for them to do so. The beliefs that students could succeed in rigorous courses and that the school or its teachers had the wherewithal to facilitate such success were glaringly absent at S1.

From the perspective of S1's teachers, their greatest challenge was to maintain academic standards during a period of shifting demographics while also acting in the best interest of individual students and satisfying regulators at all levels that they were in compliance with sometimes ambiguous, contradictory, or undesirable policies. Juggling these myriad considerations presented dilemmas for them in their classrooms. The concern of S1's science teachers for students was evident as they discussed tensions between the needs of individual students and the requirements of the school and external agencies. The science department chair, who vigorously advocated placing more students in the general track, recognized that to do so would have important consequences for individual students.

> It is easy for me to sit up here and look at numbers when they don't have any faces attached to them and say, "Well, these 500 kids should not be in CP level, but they should be in the general level, nonacademic, really, level." But then you get a little girl who works real hard and does her homework all the time and just doesn't have the reading skills, but because she works so hard she pulls a 72 for the year. And you sit there and you want to tell her, "No, I don't think you've got the skills to go to Chemistry and you should probably consider trade school." [And she is thinking] "But I want to go to Chemistry because I want to go to college." How do you tell this kid--how do you know that this kid is not going to just balloon in her junior year and become a great reader and a great student? You don't.

Our impression was that teachers at S1 cared deeply about their students as individuals. Yet, depending on their basic attitudes about the general academic ability and socio-educational background of their students, some teachers viewed the policy climate as an opportunity for increasing academic rigor for all students, whereas others saw it as an opportunity to funnel more students into low-level courses. At S1, teachers favoring both approaches seemed able to push their work life in the direction they favored despite being located in a district associated with top-down policy mandates.

Part IV: District A's S2 High

S2 High opened in 1948 to a relatively small attendance area and a predominantly white, middle-class student population. Since then the school and surrounding neighborhood have experienced major demographic changes. White flight began in the late 1960s and accelerated during the seventies. Today, virtually all of S2's students are African American and most come from poor families.

Other schools in S2's district have a similar history. Although new students--primarily minority and poor students--were moving into these areas, the long-term trend in the district's inner-city schools was toward markedly lower enrollment. The school board responded to these conditions by consolidating schools throughout the late seventies and early eighties. In 1982, S2's physical plant was expanded to make room for students from two other campuses that were then closed. Consolidation enabled S2 to make overdue renovations to the physical plant and add a fine arts center with a large modern auditorium.

Declining enrollment continued to hamper S2 at the time of our research. The regular school program, which served 1100 students the year after consolidation, was down to about 990. The campus is also home to a college-prep magnet school that serves about 160 students and is operated by a separate staff and administration. The magnet relies on Advanced Placement courses, low student-to-teacher ratios, and resource-laden school-business partnerships to attract high-achieving students from throughout the district. Magnet students, most of whom are white, are admitted on the basis of standardized test scores. The decision to house an academic magnet at S2 reflects the district's desire to fully utilize the school physical plant and to encourage desegregation. Even though there is little contact between staff and students in the regular and magnet programs, administrators are able to create the appearance of racial diversity at S2 by including magnet students in overall enrollment figures. Due to the separation of the regular and magnet school programs, our discussion of S2 refers only to the regular school program unless otherwise noted.

S2's neighborhood was experiencing a renaissance due to an influx of middle- and upper-middle-class families. These families were attracted by the relatively affordable, albeit highly fashionable, historic homes near the school. The principal hopes that some of these families, both African American and Caucasian, will send their children to S2. He believes state efforts to funnel more resources into schools through the EIA initiative will help greatly to make schools such as S2 more attractive to these families.

S2's physical plant is a conglomeration. One part of the campus holds a new brick auditorium alongside the original one-story stone building. Across the mall is a series of two-story stucco and glass buildings. Behind these buildings lie a cluster of portable classrooms and a dilapidated athletic arena. The campus is serviceable but bears signs of severe wear and vandalism. Graffiti can be seen on bathroom walls, in corridors, and on desks; litter is strewn about despite daily efforts by custodians to maintain the grounds.

Students

Despite changes in the composition and size of the student population at S2 from the late 1960s to 1980, the school has been relatively stable since 1982. According to the state education agency, S2 is in the second poorest quintile of schools in South Carolina. Over 65% of S2's students met federal guidelines for free lunch in 1990.

Students in District A generally score above the state average and below the national average on the Stanford Achievement Test and the Comprehensive Tests of Basic Skills (CTBS). S2 consistently scores below the district average on these exams, as well as on the state basic skills exam (BSAP). For example, in 1989, ninth graders at S2 scored on average at the 40th percentile in the state in reading, the 37th percentile in math, and the 48th percentile in language on the CTBS. A sense of how S2 compares nationally can be gleaned from scores on the Scholastic Aptitude Test. In 1990, when the national mean for the verbal portion of the test was 424, and the mean for math was 476, eleventh graders at S2 averaged 329 on the verbal portion of the test and 360 on math. About 40% of S2 graduates proceed to college immediately following high school.

Students in the regular school program at S2 encounter serious scholastic problems at the upper grade levels. At the same time S2's ninth graders received the scores noted above on the CTBS, eleventh graders scored at the 22nd percentile in reading, the 13th in math, and the 32nd in language. The substantially lower test scores for grade 11 students is puzzling considering that the school also has one of the highest dropout rates in the state. Losing 8.9% of its students annually, S2 has a dropout rate at the third percentile statewide. The high dropout rate has led to uneven enrollment across grade levels. In the spring of 1991, for example, the roster included 500 freshmen but only 170 seniors.

Dropout is not the sole reason for uneven enrollment across grade levels. An organizational bottleneck is also created by the district policy to administer area exams in certain courses that students must pass to be promoted to the next grade level. One consequence of district area exams is that students sometimes make normal progress in some subjects while falling behind in others. Many of these students, realizing they will never pass all area exams, leave school altogether. The attendance officer at S2 reports that most dropouts are classified as ninth graders, but it is the students who repeat ninth grade who are most likely to abandon hope of ever earning a diploma. A majority of the students who leave school before graduation are male; enrollment is evenly balanced by gender in ninth grade, but there are about 30% more females than males in the three upper grades.

Despite poor academic performance and high dropout rates, S2 boasts a high average daily attendance rate of over 95%. The school has also seen substantial enrollment gains in upper-level math and science courses in the last five years. The nature and extent of these gains will be examined in the sections devoted to the math and science departments.

Faculty

S2 has 107 classroom teachers; 42 are women and 63 are African American. The teachers have an average daily attendance rate of 98% and average 17 years of teaching. S2's average teacher salary compares favorably with other schools in the district and is above the state average. Only once since 1984 have S2's teachers seen their salaries supplemented through the state Teacher Incentive Program (TIP); most do not believe they are likely to win TIP bonuses again.

Morale varies among S2's teachers. One target teacher--an African American who grew up in the community--reported that he receives adequate support from parents. Others said parents do not do their share, complaining that many parents allow their childrens' jobs to interfere with their studies. Nevertheless, teachers recognized that some families desperately need their high school children to contribute financially to the family.

One teacher reported feeling overwhelmed by students' personal problems and difficulties maintaining discipline. She reported she had requested transfers to schools where the majority of students and teachers were Caucasian. She said the district had an informal policy to keep Caucasian teachers such as herself at schools like S2 where faculty were predominantly minority. Only minority faculty members could transfer to schools where the faculty is predominantly white. Although this teacher worked hard and showed compassion for her students, she felt she had paid a high price by taking a job at the school to begin with.

> If you teach at [S2]--it is hard as the devil to get a job in [higher status, higher paying districts]. It is like a death mark. I didn't realize coming here was the end of the road.

Many teachers commented that S2 is often regarded as an undesirable place to work. Nevertheless, the teachers we observed and interviewed seemed extremely dedicated to students and the community.

Administration

With four administrators, S2 has an administrator-to-student ratio of about 1:300. The building principal is African American, as is a woman who serves as assistant principal. The other assistant principal and the magnet school administrator are Caucasian women. The principal has been in his position since the school was consolidated with two others in 1981. Previously he taught and was an assistant principal in one of the three schools that was eventually merged to create the present-day S2. The principal, who has over thirty years of teaching and administrative experience in the district, is possibly the most outspoken administrator we encountered. He discusses openly his relationship with faculty and the community, his perspectives on district and state policies, and his vision for the school.

The principal places great emphasis on attracting new programs and greater resources to S2. He strongly supports special programs on campus for at-risk youth, adult education, and the new magnet school. He is particularly excited by the partnership between the magnet and a major computer manufacturer. The computer company allows magnet students--of which there are 160--to borrow personal computers to use in their studies. In interviews, he gave high priority to looking for additional ways to involve the private sector in the regular school as well as the magnet program and to garner resources and enrich educational programs.

The principal's concern over resource shortages is reflected in his reaction to the SIRP and TIP initiated by the state in 1984 as part of the EIA. In principle, he likes the idea that schools can procure extra funds by raising test scores. However, he argues that the rules under which schools compete for bonuses are unfair.

> If there's any one thing I fault the district and the state for--the rich get richer and the poor remain the same. . . . We are hurting [for resources]. Especially in science we're hurting. In math we are all right right now. Let's assume that a suburban school got $20,000 for EIA incentive moneys. They can buy graphing calculators for their physics class and we can't because we don't have the money. So how can we compete with them? We couldn't compete with them before and we're not going to compete with them now.

There is some merit to the argument that significant inequities are inherent in the state's EIA funding mechanism. Disparities arise insofar as schools at the bottom of a given quintile are in competition with those at the top. However, gross disparities are precluded because the poorest schools never compete with the wealthiest. The purpose in raising this issue here is not to determine whether the principal's criticisms of EIA funding rules are valid. Rather it is to illustrate the candor with which he speaks out on issues affecting his school. In this regard, it is instructive to consider other views he expressed. For example, he reports coming to verbal blows with faculty over the assumption that students cannot succeed academically because they are poor.

> My faculty and I--sometimes we part because I think the socioeconomic factors that many people use for excuses about test scores are crap. You know, I think if you expect students to do better, they will do better. . . . Faculty believe that these poor children--they don't study. They don't do this, and as a result of that the test scores [are low], and we can't do nothing about it. I believe just the opposite. I believe we can do something about it.

The principal also criticizes parents for undermining high academic expectations.

> They [parents] don't give a damn about test scores. My community is more interested in how good the basketball team is going to be, where is the band going next week? And again, talking about the school-community relationship--me and my parents, sometime we get into a real war. They'll march on me in a minute. And

> sometime I say, "You can't go. You can't do it." We can't give the impression that all we're interested in is riding up and down the road and playing basketball. And that angers lots of them.

It is in this context that the principal cites raising test scores and conducting curriculum alignment toward that end as activities that consume the majority of his time. He estimates that 60% of his time is devoted to aligning the school's curriculum with the district's. The district curriculum incorporates the state curriculum, but district guides and course outlines are much more comprehensive and prescriptive than state outlines. Alignment is expected to enhance test scores since the district curriculum incorporates state basic skills objectives.

While the principal strongly criticizes certain state policies, he supports others. For example, he applauds a provision of the EIA that requires students to pass the state BSAP exam to qualify for a regular high school diploma. He notes that only about 33% of S2's students passed the BSAP when it was first given in 1984; now about 70% succeed. He further believes that higher expectations are responsible for the improvement and says that the state has supported higher expectations by implementing the BSAP and requiring students to achieve mastery in order to graduate.

Our observations suggest that the principal is highly visible in the daily operation of the school. In contrast to some schools–where the building principal is rarely in the school, and daily decision making is left to assistant principals–S2's principal can often be found canvasing the campus and interacting with students and staff. He can also be heard daily on the intercom, urging students to work harder and behave better. He is quick to congratulate those who have represented the school well in extracurricular activities, especially students who succeed in academically oriented activities.

Math Department

S2 has eight full-time math teachers and one science teacher who conducts a single class of Precalculus daily. Four math teachers have master's degrees. Most of them have taught at S2 since the time of consolidation in 1982, and several were at the "old" S2 before that.

The math department offers 17 courses, including three levels of Remedial Math for students who fail the BSAP and four levels of General Math. The department also offers college-prep (CP) and honors levels in Algebra I and II and in Geometry, Precalculus, and Calculus. The department conducts 40 classes daily, 20 at the Algebra I level or higher. Data provided by the South Carolina Department of Education indicate substantial enrollment gains in upper-level and CP courses at S2 since 1983-84. In math, Algebra II and Geometry have shown the greatest gains. In the fall of 1984, 70 students enrolled in Algebra II. By 1986, enrollment was up to 86; in 1989 it reached 124. In 1983, Geometry had only 60 students. By 1986, the course had 106, and 165 enrolled in 1989. These trends are especially impressive considering that total enrollment in the school declined during this period. Increased upper-level course-taking was achieved through sharp reductions in enrollment in the General Math sequence. For example, General Math II had 371 students in 1983 but only 121 in 1989.

Class size varies across the math department. Big enrollment courses, such as Algebra I and General Math I, commonly have between 25 and 30 students per section. Remedial math classes are slightly smaller, but the principal complains that there is not enough money to keep enrollment in remedial classes under 20. The smallest student-to-teacher ratios are found in upper-level courses, of which only one or two sections are offered. In 1989, the two Precalculus classes had 17 students each, and Advanced Placement Calculus had just 12.

Because the organization and operation of the math and science departments at S2 are similar, we discuss them jointly following description of the science faculty and course offerings.

Science Department

The science department at S2 has only 6 teachers. The fact that the state requires students to have three credits of math for graduation but only two credits of science largely accounts for the smaller size of the science department. Nine different science courses are offered; the mainstays are General Science, Physical Science, Biology, and Chemistry. Biology is offered in a general and college-prep format, as is Physical Science. Physical Science can also be taken as an honors course. Chemistry is also offered in college-prep and honors format. In addition to these courses there is one class of Physics. Advanced Placement versions of Physics, Physical Science, Chemistry, and Biology are offered in the magnet school, but S2's head counselor reports that students from the main school program rarely take courses in the magnet program.

Four science teachers conduct five classes per day, and one teacher conducts six. The sixth science teacher conducts four science classes along with Precalculus. Sixteen of the 30 science classes taught daily are general track. The principal and counselor reported that no new science courses have been added in recent years. Courses in Cookbook Physics and Marine Biology were dropped in 1990-91 to free up teachers for freshmen level Physical Science classes. With seven classes per day, general Physical Science has the highest enrollment of any course in the department.

State department of education statistics show CP Chemistry has been the fastest growing science course at S2 in recent years. Although 87 students took Chemistry in 1983-84, the course lost students steadily until 1986-87 when only 24 students enrolled. Enrollment has since climbed; 114 students took Chemistry in 1989-90. No other science course showed significant gains during this period. The growth of CP Chemistry at S2 reflects district policy to increase CP coursetaking during the mid- to late-1980s and the support of S2's principal and faculty for the policy.

The average class size in science is between 25 and 30. Our target science classes at S2 are General Science and CP Chemistry. General Science had 20 students in the first semester and 17 students in the second; Chemistry held steady at 26.

Departmental Organization and Operation

Although there is much informal communication among math and science faculty, little formal decision-making power resides in the department. In some of the schools in the Reform Up Close sample, department chairs have primary control of teaching assignments. Elsewhere seniority is the determining factor. At S2, teachers report that the principal controls teaching assignments. Teachers are sometimes asked for their preferences, but their desires are often ignored.

A school-based management (SBM) plan has been in place at S2 since 1986. According to the science chair, the school initially devoted much time and energy to SBM activities. She reports that staff regularly attended evening and weekend meetings when SBM was first initiated. Teachers had time to discuss issues affecting the school as well as an opportunity to socialize with colleagues. But no such events were held in the year we studied S2, and the science chair said the program had all but vanished without any discussion about its future.

The nature of monthly departmental meetings also suggests that few fundamental decisions are made by departments. Administrators frequently use monthly department meetings to inform staff about changes in district or school policy. Administrators have used entire meetings to discuss strategies for raising standardized test scores or the criteria teachers should use to advise students on course selection. Department meetings are also used to plan special activities such as annual math and science fairs. Department chairs report that student discipline is the topic teachers most often raise at department meetings. Neither teachers or chairs could think of instances in which a school-wide policy had originated at the departmental level. In short, formal decision making at S2 is top down.

Interviews and classroom observations show department chairs are exceptionally committed to their work. For example, the science chair reports frequently staying at school past dinner to distribute chemicals and other materials to classrooms, to complete accreditation reports and paperwork required by the state, and to do other tasks. On two occasions we saw her devote her lunch period to preparing a lab for her Chemistry class. Chairs also attend meetings regularly. They meet monthly with their departments, with the SBM team, and with other chairs in their discipline from across the district. Chairs also attend more workshops than the typical teacher. Often chairs will represent their entire department at workshops, reporting back on matters affecting all teachers. Chairs also appear to spend more than the usual amount of time preparing for their own classes. They report being especially meticulous about reconciling their daily lesson plans with district curriculum policies. For example, they consult the curriculum guide to make sure they are using the textbook in the specified manner and covering the objectives stressed by the state and district.

For the extra work they do, chairs receive an annual salary supplement of $20 for each teacher they supervise, and they are relieved of homeroom duties, which gives them an additional 25 minutes of planning time daily.

Important questions are raised by the above description of departmental operation and the role of chairs. Why does the administration resist delegating increased power and responsibility to such committed members of the organization? What effect, if any, does the strict adherence of chairs to district policy have on the practice of other teachers in the department? These questions will be addressed in the sections on Distinctive School Practices.

Instructional Resources

Inadequate instructional resources are a perennial problem at S2. The target teacher for General Science worked the first three weeks of school without textbooks. The target teacher for Algebra II felt upper-level math classes were disadvantaged because they lack graphing calculators that are available to students in wealthier schools. Others said they would like to see computers in regular classrooms as well as in computer labs. The most severe shortages of supplies and equipment exist in science. The science chair reports that shortages stem partly from certain school budgetary practices. The most problematic practice entails the use of a single pool of funds for purchasing equipment and chemicals for both the regular and magnet science program. According to the science chair, this arrangement has resulted in the magnet program receiving a disproportionate share of science department resources.

For whatever reason, teachers in the regular program report they often lack the materials needed for "hands on" labs. The chair believes most science teachers fail to satisfy a district requirement to spend 20% of class time in labs. She says teachers fall short on lab time even though they often count paper-and-pencil exercises taken directly from texts as labs.

When asked whether she thinks the 20% lab-time rule is realistic, the science chair responded, "I think so, but a lot of times they [the teachers] don't think so." She goes on to say that teachers must make special efforts if they are going to meet lab-time requirements and that they cannot rely on the school to provide them with everything they need.

> See, if you're not able to see what you can substitute in place of materials, then it looks like you don't have what you need--and some folks just are not lab persons. If the lab calls for x, y, and z, that's what needs to be there. But you take a teacher like Ms. T., you know, she'll make the kids bring vegetable cans from home if she doesn't have beakers to heat water in.

District administrators are concerned with the impact of supply shortages on science labs. In 1990-91, the district offered an inservice on ways of doing labs with fewer supplies. According to S2's science chair, the main emphasis of the district inservice was on reducing the amount of chemicals used in chemistry labs; purchasing such chemicals consumes the bulk of the science supply budget. The district hopes that more efficient use of chemicals will free up funds for other uses.

Another strategy schools in District A use to reduce shortages is to charge student fees that are then used to purchase supplies. At S2, each department decides how much to charge students taking their classes. Most departments collect between $3 and $7 per student. Fees for science courses are usually near the top of the range; for math courses, usually near the bottom.

Math and Science Curricular Control

Textbooks and Curriculum Guides

As noted in Part I, textbook adoption and selection is done at the state and district level. District A policy requires teachers to use district curriculum guides as their primary resource on curriculum, pedagogy, and evaluation and to use textbooks only to supplement district curriculum.

Despite district policy on curriculum guides and texts, there is no formal mechanism for monitoring what teachers actually do. According to district administrators, building principals are responsible for ensuring that teachers use the guides. Principals say they check lesson plans for coverage of state and district objectives--especially those tested by the BSAP exam--but they lack a mechanism for monitoring teachers' text and curriculum guide use. How teachers respond to district policy on curriculum guides and textbooks in the absence of a system for monitoring compliance will be discussed in Distinctive School Practices.

State and District Tests

The impact of state and district tests on curriculum at S2 varies across disciplines and courses. Certain effects of the Physical Science area exam have already been noted. The district recently introduced similar tests in General Math I and Algebra I. The math chair told us she changed the content of her Algebra I class when the district introduced the area exam for the course.

> I took things that they will need to know for the test and I'll spend more time on that; I'll really work with it. Whereas something that they would not have on their test, I may spend less time on it.

This teacher views area exams as a necessary evil but is generally in favor of them because she feels they make students accountable for mastering material.

The state's BSAP high school exit exam covers math but not science; thus, math teachers are much more likely than science teachers to tailor their curriculum to BSAP objectives. Also, because it is mainly grade 9 and 10 students who have yet to pass the BSAP, and because these students are concentrated in lower-level math courses, curricula in lower-level courses are more oriented to the BSAP.

The state requires all students who fail the BSAP math subtest to take remedial math. Many South Carolina schools, including those in the present study, use computerized instructional packages for remedial math. Although the state does not itself produce software packages for BSAP instruction, it does recommend particular software to schools and encourage large expenditures of SIRP funds for computer hardware and software for remedial instruction. The schools we studied were so committed to using the software recommended by the state for BSAP instruction that they had invested tens of thousands of dollars each in hardware systems that could run only software produced by the hardware manufacturer. Many district administrators, principals, and teachers are attracted to computerized instruction because it makes efficient the kind of drill-and-practice instruction associated with success on BSAP exams. Computerized instruction almost guarantees that remedial teachers will conform closely to state regulations for remedial course curricula.

The state provides all math teachers with a manual that specifies objectives for the BSAP exam. The manual has over 200 pages and includes activities teachers can use in their classrooms.

This manual commands little attention from teachers of upper-level courses but is sometimes used by teachers in lower-level courses. None of S3's target teachers thought the state manual influenced their curriculum.

As noted earlier, the state uses the BSAP scores each year to determine which schools receive SIRP and TIP bonuses for improved academic performance. Thus, all S2's teachers, including those with upper-level courses, have a potential stake in the program whether or not it directly affects curricula in their courses. However, as the science chair reported, there is currently little interest in the incentive implications of the BSAP.

> I think we've only gotten it [the incentive bonus] once. . . . See what happens is, if your test scores go up this year, the next year they have to go up above the point where you were, not back down to your original level. So if you push your scores up ten points overall, you have to move on top of that ten points the next time to qualify, and I think that is what hurt us. It was just not possible to move the kids from where they were up and then go on.

The chair's assessment of why S2 has not successfully competed for SIRP and TIP awards misrepresents somewhat how the awards are determined in that awards are actually function of test score gains relative to other schools of similar SES. Hypothetically, if all schools in a group were to produce lower test scores in a given year, the ones that dropped the least would still receive SIRP and TIP awards. Likewise, a school that produces the same high scores two or three years consecutively will likely come out on top each year. It is nevertheless important to note that many teachers, like the one quoted above, overestimate the level of test scores necessary to win awards: teachers' beliefs about the programs, not the technical nuances of SIRP and TIP policy, determine whether the teachers are motivated by the programs. Irrespective of the financial implications of the BSAP, most teachers at S2 like the exit exam because they feel it motivates students to take classes more seriously.

Professional Development and Evaluation

S2 conforms to state and district regulations on professional development. Except for funds and services provided through the federal Eisenhower program, inservice programs receive little funding. In South Carolina, district administrators seem more concerned than state officials with soliciting teachers' suggestions about inservice topics, but teachers rarely assume direct responsibility for inservices.

The district has no formal policy for determining workshop topics. Among the topics noted by RUC target teachers at S2 during the 1990-91 school year were development of syllabi for district math courses, a meeting of district Geometry teachers to discuss teaching strategies and content, development of district area exams for science courses, writing of curriculum guides for science courses, and identifying strategies for raising school BSAP scores. Teachers reported mixed reactions to the inservices, although most teachers could remember one they found useful. Teachers were most positive about workshops that introduced them to new methods for presenting traditional topics. None of our target teachers at S2 thought state or district inservices had substantially changed course content.

The indifference of S2's teachers to inservice is not surprising. As noted in Parts I and II, the state and district spend very little on inservice. According to the District A's curriculum specialists, funding constraints preclude involving teachers in extensive discussion of curricular issues. Curriculum specialists felt that the investment in inservice programs would have to be doubled or tripled to provide conditions under which they might systematically address the nature of mathematical and scientific knowledge and pedagogical practices that reflect different conceptions of disciplines.

Teachers at S2 are required to take 6 credit-hours of continuing education every five years. The district strongly encourages teachers to take courses that emphasize subject area content knowledge by reimbursing teachers for tuition for qualifying courses. The continuing education requirement creates no special burden for S2's teachers, because numerous colleges exist in the community.

Teacher Evaluation

Some teachers criticized the district evaluation system (see Part II) on the grounds that observations are too frequent. Others question the validity of the evaluations, arguing that poor teachers can easily deceive evaluators for a few days out of the year. There is an apparent tension between these two statements. One perspective could be seen to imply a need for more frequent observations while the other suggests that fewer would be desirable. Teachers we interviewed neither noted this tension nor suggested ways to resolve it.

Course Sequences in Math and Science

The district recommends standard course sequences for each track (see Part II). Only students who enter ninth grade having already completed Algebra I reach the fifth course in the Honors sequence. CP students rarely reach Calculus unless they have taken Algebra I in eighth grade. In 1990-91, S2 did not offer regular Calculus, so AP Calculus was the only option for students going beyond Precalculus. All twelve of the students who took the AP Calculus class did so as honors students.

A counselor at S2 reported that students are advised to select all their courses from the same track. A small percentage of students who take General Math I in ninth grade reportedly switch to CP Algebra I as sophomores. Counselors recommend moving a student to a higher track only if the student has earned a B or better in math and science courses in the preceding year. For example, a B is required to move from General Math to Algebra I, or from General Physical Science to CP Biology

I. In 1989-90, counselors began advising CP students to take Algebra II before Geometry because they believed it might improve PSAT and SAT performance.

Examination of course enrollment data indicates that no more than 35% of S2's freshmen enter the CP track. A handful of students also enter the honors or AP sequence. The remaining 60% of the regular school population are evenly divided between general and vocational tracks. The main distinction between vocational and general students is that vocational students leave S2's campus each afternoon for classes at the district's centralized technical school.

Course Selection Process

Course selection at S2 is coordinated by the guidance department. Because the counselor-to-student ratio is about 1:400, homeroom teachers are responsible for providing students with basic information and monitoring course selections. Counselors review students' course selections as they are received from homerooms.

Each spring students choose courses for the following fall. Most students simply follow a four-year plan for their program of studies. Four-year plans are typically established by middle school counselors when students are in eighth grade. Middle school counselors receive their information on course placement from counselors at the receiving high school. Parents have considerable formal control over their childrens' course selections. The head counselor said her staff urges parents to change their child's course selections in cases where they think the child has signed up for a course he or she is likely to fail. However, counselors were also emphatic about the parents' ultimate control over course selection.

Course Selection Criteria

Counselors and department chairs cite grade point average, test scores, performance in previous courses, and teacher recommendations as key factors for track placement and course selection. Students who have a B average, the necessary prerequisites, including passing scores on the necessary district area exams, and favorable teacher recommendations are routed into the college-prep track. Students who meet the CP criteria and have exceptionally high test scores are encouraged to take honors courses. Students who fail the mathematics or English portion of the BSAP in grade 10 are required to take remedial courses and are placed in the general track until they pass the exam.

Student performance on the math portion of the BSAP exam sometimes interferes with progress in other areas because certain math courses are prerequisites for particular science courses. For example, completion of Algebra I and concurrent enrollment in Algebra II is required for Chemistry. Given that the school already has a general rule that students cannot cross track boundaries in selecting courses, it seems redundant for the school to specify that students taking remedial math cannot take CP science courses. The rule exists nonetheless and serves to underscore the fact that the school will leave nothing to chance when it comes to maintaining separation between tracks.

Distinctive School Practices

Many key state and district policies are designed specifically to improve academic achievement. We return now for closer examination of how S2's principal and staff respond to such policies. This discussion will show that the principal goes beyond merely accommodating policies stressing academic achievement; he pursues them vigorously. It will also demonstrate that teachers support the principal in important ways.

Raising standardized test scores is central to S2's struggle for academic improvement. The state BSAP program and district area exams are largely responsible for focusing so much attention on standardized tests at the school level. The principal's support for these policies is readily apparent. Teachers say the principal often uses the public address system to admonish students to do their best on tests. He tells students that exams are consequential for them as individuals and for the school as a whole.

Earlier we quoted the principal as estimating that he spends 60% of his time on curriculum alignment. His primary aim here is to insure that teachers are enabling students to succeed on exams by adhering to the curriculum on which exams are based. Although our data raise doubts about the extent to which curriculum alignment has been achieved, it is clear from conversations with target teachers that the principal discusses alignment with staff more than many principals in our study. His determination to convey curriculum policy to teachers demonstrates his support of state and district policies for raising basic skills achievement.

Many teachers also support the state and district tests. One target teacher objected to the tests because she thought the exams put too much pressure on students--even to the point of exacerbating the dropout rate. Others like the leverage they feel tests give them in holding students accountable to academic standards. Teachers feel students are easier to control in class when they realize mastery of material is necessary for school success.

Another important aspect of the relationship between teachers and the principal is their general agreement on the importance of high academic expectations. High expectations are particularly evident in college-prep courses. For example, our target teacher for Algebra II constantly pushes students to put forth their best effort. Unlike some teachers, he confronts students who doze in class or fail to turn in homework, and he insists on doing all the word problems in the textbook despite student resistance. Observations show that this teacher demands more from his students than computational proficiency; he expects students to be able to explain how problems are solved. According to him, high school graduation is only an immediate goal. Ultimately he wants students to be competitive on nationally standardized tests, attend good colleges, and pursue careers in mathematics.

The target teacher in Chemistry has equally high standards for students. She wants her students to acquire the skills and knowledge necessary for success in college chemistry courses. Her classroom demeanor is business like, and she is an efficient classroom manager. Observing her class it is difficult to detect evidence--in her behavior or that of her students--to justify the school's reputation for low academic achievement.

The one course in which academic expectations appear low is a General Science course composed primarily of students receiving remediation in math and English. It is the teacher of this course who dislikes exit exams and doubts the wisdom of the principal's habit of pushing students to raise test scores. Here it is useful to bear in mind that students in courses such as General Science are the ones most likely to be hampered by state and district testing practices.

A concerted effort to steer students away from general courses and into CP courses constitutes the other key element in the school's strategy for raising academic achievement. As noted earlier, the school has made substantial gains in this area. Again, with the exception of the General Science teacher who believed students were being pushed into difficult courses against their will, target teachers at S2 favored an emphasis on rigorous courses. At no time did we hear teachers complain that insufficiently prepared students were causing them to adopt lower standards. Likewise, none of the teachers we interviewed favored reversing the trend toward college-prep courses. If teachers complained at all it was about the difficulties involved in raising students up to the level where they could succeed in demanding courses. But a commitment to overcoming obstacles rather than submitting to academic retreat and entrenchment characterizes the attitude of college-prep teachers at S2.

The commitment of S2's teachers to raising student performance through increased enrollment in college-prep courses is particularly remarkable when we compare S2 to S1. Enrollment trends at S1 have undergone similar changes; however, teachers there have responded quite differently. Teachers at S1 seem preoccupied with the impact of this trend on the academic integrity of courses and less inclined to emphasize potential benefits to students. The contrast between teachers at S2 and S1 suggests an important element of the organizational culture of S2. In many schools, including S1, academic disciplines and the institution of the school itself seem central to teacher culture. In contrast, teachers at S2 appear to subscribe to a conception of the role of teacher that emphasizes the importance of community and students as individuals.

The commitment of S2's staff to students and the community is apparent not only in the effort teachers invest in their instruction but also in their informal interactions with students. Even though most teachers clearly retain authority in their relations with students, we witnessed interaction between staff and students that suggested familiarity and respect. Several of the teachers we interviewed and observed--teachers who had grown up in the community--conversed freely with students about mutual acquaintances and experiences. Students seemed to respond favorably to teachers and were thoroughly attentive and polite.

The preceding discussion suggests that staff commitment to the welfare of students and the fulfillment of professional duties is a great asset to S2 as an organization. Also, the presence of a working consensus between staff and administrators over certain basic goals--such as the importance of academic rigor and achievement--engenders further consensus about organizational strategies for pursuing goals. Clearly, S2 has made considerable progress according to its own criteria: college-track enrollment is increasing and test scores are on the rise. When the BSAP was first required for graduation in 1986, only 33% of S2's students passed all three sections of the test on the first attempt. Three years later 70% of all students passed the entire test on their first try. Results such as these cannot be ignored.

Much of the progress toward higher test scores and increased college-track enrollment at S2 can be attributed to decision-making practices in the organization. Following district tradition, the principal retains power and makes major programmatic decisions without extensively consulting teachers. He is able to quickly change school goals and then change relevant policies (e.g., the criteria governing student track placement) to achieve such goals. From a strictly pragmatic point of view, excluding teachers from certain decisions permits the principal to proceed more swiftly than might otherwise be possible.

If raising basic skills test scores and college-track enrollment were the only challenges facing S2, there might be little reason to question current decision-making practices. However, there are other issues confronting S2, and it is instructive to explore these challenges in relation to the dominant decision-making style. In doing so it becomes apparent that the school faces a dilemma: some of the same organizational practices that advance certain goals may impede others.

Although we do not desire here to diminish the significance of raising academic achievement and increasing access to college-track courses, it is important to recognize that these changes have occurred without regard for the content of the tests and courses on which the organization bases its criteria for success. It is a positive sign that students are doing better on the state exam and taking more rigorous courses, but these exams and courses fail to reflect the kind of knowledge that many people--including curriculum experts within S2's own district--believe students should be acquiring. The state exam covers only rudimentary concepts and computational skills. Likewise, memorization and routinized exercises consume most of students' time, even in college-prep courses. Whereas many people in the curriculum and policymaking community are currently urging schools to integrate disciplines and emphasize conceptual understanding, S2 has worked to intensify instruction of basic skills and emphasize courses taught with traditional content and pedagogy.

Neither individuals within S2 nor the staff as a whole can be criticized for how they have directed their efforts; basic skills intensification is precisely what the district and state have been clamoring for throughout the decade. The school's current emphasis represents an effective response to those demands. However, in choosing this direction, it appears the school may also have increased reliance on decision-making mechanisms that may be antithetical to new and different goals.

Difficulties the principal encounters in the area of curriculum alignment illustrate problems inherent in current decision-making practices. As noted above, the principal invests a great deal of time in curriculum alignment. Interviews with the principal suggest he views alignment as having two major components: (1) getting teachers to cover objectives on area exams and the BSAP exam; and (2) getting teachers to adhere to district curriculum guides. By emphasizing the negative consequences of test failure the principal has had moderate success convincing staff to systematically cover BSAP objectives.

One reason the principal has had success convincing staff to teach to state and district tests is that it affects only teachers of lower-level courses where the vast majority of basic skills instruction occurs. Teachers with intermediate and advanced courses--often the most senior and autonomous members of the faculty--are of no immediate concern to administrators seeking to raise basic skills achievement. Another factor that functions to the advantage of principals who desire basic skills intensification is that teachers require no new knowledge to pursue this goal. Teachers are merely required to concentrate more heavily on the kind of instruction they have traditionally provided.

The principal has had far less success convincing teachers to adhere to district curriculum guides. Although department chairs report using the guides in their own classes, they doubt that others pay attention to them. The chairs' suspicions are readily confirmed by other teachers who say they refer to guides only as secondary resources and depend primarily on their textbooks to maintain continuity in courses. One teacher was particularly negative toward the curriculum guide for her science class.

> We all hate it because it doesn't go in the order of the book and it blends different chapters. I mean, when you're going through the curriculum guide that we have, it's not for your textbook or anything. You might have--like last year we focused on physical science because I'm more used to that--chapter 5 and chapter 12, all that information together. And my kids here get confused if you give them an assignment of chapter 5 and an assignment of chapter 12 and you try to blend it.

As this teacher notes, the guides and texts for many classes reflect substantially different topic sequencing. We use data from teacher logs for further evidence that most of S2's target teachers heavily discount district guides in daily classroom practice. Examination of the log data on daily textbook use shows that one target teacher--a department chair who reported that she adheres to the curriculum guide--does not go through her text sequentially. Rather she jumps forward and back, sometimes using a page or two from different parts of the book in a class period. Conversely, teachers who report that they ignore the guides almost always follow their text sequentially. Although the latter group may skip sections of the text, they rarely return to an earlier section of the book or use pages from various sections on the same day.

The tendency among teachers to discount the role of district curriculum guides in daily classroom practice short-circuits the efforts of administrators at various levels. First, it makes impossible the type and degree of curriculum alignment desired by S2's principal. Second, as will be recalled from the section on curricular control, redesigned curriculum guides are central to the district's strategy for infusing new curricula and pedagogy into classrooms. Clearly the guides cannot have the intended effect at S2 if teachers ignore them.

The decision by the science chair to use district curriculum guides appears to have no effect on the other teachers in the department. Exploring the indifference of science teachers to the classroom practice of their department chair provides clues to understanding the relationship between school level decision-making practices and teacher classroom practice. Although the school does not give chairs the power to make and enforce key decisions, the organization does take steps to underwrite the chairs' authority. The school gives chairs a unique title and, by virtue of their regular communication with administrators, chairs occupy a strategic place in the information network on which other teachers rely. These factors enhance the authority of chairs and make them relatively visible within the organization. Given this arrangement, one might see the attention chairs give to their own practice as tacit recognition of the authority they acquire by virtue of serving in the role. Since much of a chair's authority derives from his or her responsibility for conveying the official policies of the organization, it is understandable that chairs would not want to compromise their own legitimacy by failing to exemplify organizationally sanctioned practice in their own classrooms.

The indifference of other teachers to department chairs is probably to be expected, given there exists no mechanism to encourage teachers to look to chairs as exemplars of approved practice. For example, chairs do not observe teachers or act as mentors. Furthermore, there are no explicit criteria guiding the selection of chairs. There is no guarantee that chairs will be considered by their colleagues to be proficient instructors. In the absence of mechanisms such as these, teachers and chairs appear to de-emphasize interacting over curriculum and pedagogy. In essence, the principal at S2 controls decision making by retaining as many prerogatives as possible for himself, but allowing chairs some independent but weakly formulated authority. Chairs use their authority to reinforce organizationally sanctioned practice but do not attempt to exert an independent effect on the department.

The traditional, top-down decision-making model in place at S2 may be effective when teachers are simply being told to work harder at familiar tasks. But it holds little apparent promise for administrators who want teachers to adopt new content and pedagogy. New priorities such as higher order thinking skills, teaching for conceptual understanding, and integration of disciplines are now being emphasized by the curriculum specialists and other central administrators in S2's district. The new goals are vigorously supported by state and national professional organizations for math and science. For example, the state education agency in South Carolina is contemplating integrating higher order thinking skills into future versions of BSAP exams.

S2's district already has two programs that could be reorganized to more fully involve teachers in dialogue about fundamental issues in curriculum. First, teachers could be more involved in writing of curriculum guides. Such involvement currently varies widely among schools. Teachers at S1 were more involved than those at S2 in committees revising curriculum guides in math and science. S1's teachers also reported being more committed to adhering to curriculum guides in their classes.

Teacher involvement in district workshops designed to familiarize teachers with new guides is also unsystematic. If all teachers are expected to adapt to revised curriculum guides, then they should be engaged in dialogue regarding the rationale behind the guides and their usage. Curricular change could be given greater visibility at the school level. Departmental meetings could be reformulated to give teachers regular opportunities to discuss developments in curriculum and pedagogy. With support from the district and state, increased commitment to teacher inservice and continuing education could extend these discussions.

These are only examples of strategies that might expand the knowledge on which teachers base classroom practice in math and science. State and district changes may be enhanced by simultaneous re-examination of school level practices. There is no evidence that qualitative changes in course content and pedagogy are likely to result under the school-level administrative practices currently in place at S2. A realistic assessment of the level of power most principals have over policy implementation suggests that relearning how to interact with teachers over instructional issues may be more effective than the traditional approach. Top-down decision making has not compelled teachers to use district curriculum guides. It will probably be no more effective in promoting new pedagogy and an emphasis on conceptual understanding.

States such as South Carolina may benefit from empirical examination of the impact of policies that tie incentives and rewards solely to basic skills exams. The failure to do so may discourage principals and other administrators from advocating instruction that is not believed to contribute directly to performance on these exams.

In conclusion, S2 is an organization subject to changing demands and deeply affected by problems as well as regulations beyond its immediate control. Strategies used by S2's faculty and administrators to remedy one problem often exacerbate others. Examples of dilemmas administrators and staff face at S2 have been examined to show how decision-making practices oriented to basic skills achievement undermine teacher involvement in important curricular and pedagogical issues.

Finally, the organizational challenges and responses in evidence at S2 resemble those found in many schools. School problems are not the fault of individual administrators or staff. Problems stem from systemic dynamics that affect many schools in this and other districts. Insights gained through examination of practices at S2 will inform our understanding of other schools as well.

Part V: District B's S3 High

S3 High is situated in a rural community some 30 miles from the district office and 60 miles from a major city. One's first view of the campus is of the classic single-story brick building that houses the high school. Behind the high school is a small middle school that serves about 350 students in grades 6-8. Beyond the middle school lie numerous portable classroom units that have been added as needed since the 1960s.

The physical plant at S3 is in remarkably good condition for a school built in the early 1930s. The exposed pipes of antiquated plumbing and heating systems are visible throughout the building, as are the original varnished hardwood planks. But the facility is well maintained and free of litter and graffiti. The lawn in front of the school as well as the playing fields beyond are immaculately manicured and edged with freshly trimmed hedges.

Students

In December 1990, about 500 students attended S3. Six seniors had dropped out, bringing enrollment for grade 12 down to 112. The remaining 400 students were spread evenly across grades 9-11. Most of S3's students are from lower to lower-middle-income families. The state education agency considers S3 a Category Two school, meaning it is in the second poorest quintile in the state. About 25% of S3's students take free lunch, but the counselor and others said many eligible families do not apply to the program due to the stigma associated with not being able to take care of themselves.

The racial composition of the school is about 70% white, 30% African American. Most of the white students live in homes comprising the relatively prosperous village surrounding the school. Almost all the African American students ride the bus to school each day from small dilapidated shanties scattered along the county's back roads.

The school has little difficulty getting students to school and keeping them there. Average daily attendance for the years 1987-1989 ran between 95% and 97%. For this same period the school's dropout rate ranged from 2.4% (76th percentile for the state) to 3.3% (53rd percentile for the state). This translates into a loss of about 15-17 students per year, most of whom come from grades 9 and 10. S3 has a very low student turnover rate, owing in part to its large attendance area. Students have to move as much as 30 miles in some directions before they reach the adjacent school attendance area.

S3 experiences only mixed success regarding academic achievement. In the area of basic skills achievement, as measured by the state's grade 10 BSAP exam and the CTBS for grades 9 and 11, S3's students showed consistent improvement for the years 1986-88. For those three years the school won SIRP awards, and most teachers and the principal also took home substantial teacher and principal incentive bonuses. For reasons discussed later, the school did not produce the test score gains needed to win SIRP and TIP awards for the 1988-89 school year.

S3's students do not fare well beyond basic skills. Only about 35% of the school's students begin their high school program in the college-prep track, and many of these students abandon CP course work after grade 10 rather than advance to difficult subjects such as Chemistry and Algebra II. Only about 30% of S3's graduates continue their schooling at the postsecondary level, including technical school and junior college. The average score for the relatively few students who sit for the SAT is below the 25th percentile nationally.

The counselor, principal, and teachers all believed that students were highly apathetic toward academics. The target teachers for CP Physical Science, CP Biology, and CP Algebra II said many of their students, although capable, were unmotivated and function below the expected level in these courses. Each teacher reported going slower than was desirable, or even justifiable, due to student disinterest. The school counselor agreed with teachers that many students would be better off in non-CP classes but attributed the problem to a South Carolina law that gives parents full authority over children's course selections.

Faculty

S3 has a highly stable faculty of 30. In 1989-90, no teachers left the school, and one new faculty position was added. Three of four target teachers at S3 had taught at the school for more than 10 years. Because of the small size of the faculty, most teachers have responsibilities extending beyond the classroom, including hall and lunchroom duty, supervision of extracurricular activities, and coaching. Five faculty members teach courses in two different departments.

Female teachers outnumber males in most departments. Five of seven math and science teachers are women. Three of the seven have master's degrees, the rest have bachelor's degrees. Two African American teachers and a Hispanic assistant principal are the only nonwhite professional staff in the school. The principal said that one African American teacher (the RUC target teacher for CP Physical Science) had been at the school for decades, and the principal was intent on keeping him there. The principal reported that he had actively recruited the other African American faculty member after she had established a reputation as an outstanding teacher at another school in the district. The principal regretted the fact that he had not a single African American applicant for a teaching position in over 10 years. He attributed the absence of minority applicants to the fact that few college-going African Americans are attracted to low-paying occupations such as teaching, and those who do enter the profession usually seek employment in high paying suburban districts.

Our impression from teacher interviews and observations is that faculty morale at S3 is exceptionally high compared to the other schools in the sample. S3's teachers are especially positive about relations among faculty and between faculty and the principal. They are less positive about the academic performance of students, as will be evident in the discussion of Course Selection Process and Criteria, yet teachers also emphasize that students are "great kids," well behaved in class, and respectful of faculty.

The presence of high morale among S3's faculty is corroborated by teacher questionnaire data. On the questionnaire completed by all RUC teachers, S3's teachers score highest by far on collegiality, shared beliefs, and teacher satisfaction. Teachers at S3 are also more favorable about their students on the student behavior scale than any other faculty. However, on the student ability scale, S3's teachers put their students in the middle of the pack.

Administration

From the moment we arrived at S3, it was apparent that the principal's authority was undisputed. His imprimatur was plainly evident on curriculum policy, faculty hiring and supervision, and acquisition and distribution of curricular resources. Largely due to his desire to win the cash awards given by the state to schools, teachers, and principals for improved test scores, issues of curriculum and instruction were paramount to the principal. In fact, as we discuss later, he invested far more time and energy in winning SIRP, TIP, and PIP awards than either of the two South Carolina urban district principals in our sample.

S3's principal is a soft-spoken man who clearly states rules and policies for conducting the business of the school. Perusing the faculty handbook provides one with concise illustrations of the principal's approach to administration. The first page of the 1990-91 edition states five goals for the school year. The first three goals are statements about the levels of student attendance and achievement the school must achieve to be competitive for SIRP and TIP awards. The fourth is a general statement about meeting all state and school credentialing standards. The last goal states, "A positive relationship will be maintained between the school, faculty, students, and the community."

It is telling that the principal's fifth goal implies that, for him, "the school" does not include students or teachers. Teachers told us that in many respects the principal is "the school," every important decision goes through him. This probably explains why S3's faculty gave their principal the highest rating by far for the sample on the leadership scale and placed themselves at the middle of the sample for teacher control.

Another illustration of the principal's desire to run a tight ship and dictate certain aspects of classroom practice with great specificity is found in the faculty handbook, which the principal wrote. In a 6-page section entitled *Student discipline and classroom management*, the principal provides teachers with 34 specific strategies for effective classroom management. Examples are shown below.

> Let them (students) live up to your good opinion of them by praising them, individually and as a group, for close attention, good attendance, good work, even honest effort. Youth crave attention and secretly want to admire adults. Help them to like their better selves.
>
> Discourage calling out of answers (in class) by saying, "I'm glad to see that you are interested, but in the future, please raise your hand if you wish to recite."
> (For unruly classes) Get the ringleader; the others will follow like sheep. However, avoid comparing the good with the bad. Never punish an entire class except with a brief silent period, preceded by an explanation--if you cannot locate the offender or offenders.

Despite his strong control over school policy and teacher conduct, the principal expressed much confidence in "his" staff. One example of his satisfaction with faculty was evident in his comments regarding the process through which the school had raised standardized achievement test scores in recent years.

> I really think the main thing at this school has been the staff that I have now, and myself included, and the high expectations.

It was apparent that the principal was prepared to work with and support faculty when he felt it would benefit the school. For example, when the target teacher for CP Biology considered taking a job in the suburban school district where she lived, the principal got her to stay by revising teacher assignments. This change enabled the teacher to drop courses she disliked (i.e., general track Physical Science) and fill her schedule entirely with courses in Biology, her area of certification. Other teachers offered similar examples of the principal's willingness to accommodate their needs and determination to maintain a strong, committed faculty.

Math Department

The math department at S3 consists of three full time and three part time teachers. All of the full time math teachers are female, one part time teacher is male. One full time math teacher handles all the remedial classes, to which students are assigned for low scores on the BSAP in grades 8 or 10 or the Stanford-8 in grade 9.

Teachers at S3 have one preparation period and teach six classes daily. For the year of our study, the math department as a whole conducted daily classes in 10 different courses. The courses taught, with the number of classes for each course in parentheses, included Remedial Math I (5), Remedial Math II (2), General Math I (2), General Math II (2), General Math III (2), CP Algebra I (4), CP Geometry (2), CP Algebra II (3), Algebra III/Trigonometry (i.e., Precalculus) (1), and Calculus (1). Calculus was added in 1987. Also, in 1987, the district initiated courses in Computer Math, two of which continue to be offered at S3.

The biggest change in the math department concerned the Remedial Math courses, which came on line in 1986. In 1989, these courses became mandatory for students with low BSAP test scores.

Informality characterizes relations among the members of this small department. According to teachers, informal communication between individuals is usually sufficient to keep everyone informed about matters of general concern. Scheduled meetings of the department are brief and few. Typical agenda items for department meetings include discussion of departmental efforts to monitor and remediate students who score low on the math portion of BSAP and Stanford-8 exams. The department had recently met several times to create lists of course objectives, based on current textbooks, and to correlate those objectives with state objectives, especially those covered on BSAP. These lists were to be forwarded to the district office where administrators planned to use them in creating district curriculum guides.

The department did not concern itself with teacher assignments because they considered this the principal's territory. Adding or eliminating courses was also considered the principal's prerogative, although he usually consulted affected teachers as well as the guidance counselor who helped create the master schedule.

The district requires departments to send at least one person to all relevant district and state workshops and conferences. Teachers in the math department generally take turns attending workshops and later briefing others on what was covered.

The average class size at S3 was quite low compared to other schools in our sample. In math, teachers said most classes had 20 to 25 students. Teacher questionnaires, which provide detailed data on seven classes across the math department, reveal a class average of 17.25 students.

S3 had achieved small classes through changes made possible by deregulation. SIRP recipients automatically enjoy a two-year exemption from most regulations contained in the state Defined Minimum Program. Deregulated schools are free to assign teachers to courses in subjects for which they are not certified, change the school schedule and allotment of time to subjects, exceed the normal requirements for maximum class size, and so forth. S3 used deregulation to go from a six- to a seven-period day, in which teachers have six as compared to the usual five preparations. This change resulted in the shortening of class periods to 45 minutes from one hour and a drop in average class size from 30 students, in 1988-89, to about 20, in 1989-90. Schools cease to qualify for deregulated status in any two-year period in which they do not win SIRP awards.

Department chairs at S3's district are paid $250 annually to fulfill limited administrative duties. The math chair reported that she frequently acts as a conduit between district administrators, including the math curriculum specialist, and other teachers in the department. She also records and files the proceedings of departmental meetings. A third function she performs is to observe each teacher in the department once per semester, as required by the district. The purpose of the observation is not clearly prescribed, but seems intended to provide teachers with an opportunity to get informal feedback from a veteran colleague. Finally, she reported serving as a "sounding board" for other teachers in the department in matters ranging from curriculum and pedagogy, to classroom management, to relations with the principal and others. When asked about the way in which the chair's role is structured, the math chair could think of nothing noteworthy that she would like to see changed.

Science Department

S3's science faculty consists of two full-time teachers plus the department chair, who teaches two classes of General Math along with four classes of CP Physical Science, and a fourth teacher who splits his duties between general track Physical Science and World History. The department chair, especially given the small size and remoteness of the school, felt the school was fortunate to have three science teachers who hold master's degrees in the subject areas they teach.

The six science courses offered at S3 (with the number of classes for each course shown in parentheses) include General Physical Science (3), CP Physical Science (4), General Biology (3), CP Biology (3), CP Chemistry (3), and CP Physics (2). No science courses had been added or dropped in recent years. Prior to implementation of the EIA, S3 offered Chemistry and Physics in alternating years. Since the new EIA graduation and college entrance requirements came on line, beginning with the freshmen class of 1986, student demand for Chemistry and Physics has been strong enough to justify offering both courses every year. Under deregulation, class sizes in science have dropped from 30-35 down to 20-27.

The target teacher for Biology mentioned that she hoped to introduce a course in Advanced Biology for college-bound students who want more science after Chemistry but are not strong enough in math to take Physics. The principal was open to this but was postponing the final decision until the end of the year when they would know how many students had passed CP Biology and were thus eligible to continue on to an advanced course. Unfortunately, even though she wanted very much to teach Advanced Biology, the teacher feared that she was going to have to dole out a substantial number of failing grades in Biology.

Science teachers meet as a department once each month, or as needed. The target teacher for Biology said it is easy for the three main science teachers to coordinate their activities, especially because she is in a car pool with the woman who teaches Chemistry and Physics. When the three science teachers do meet as a group, the topic that they are most likely to discuss is the content of workshops and inservices they have attended. District policy requires all schools to have representatives from appropriate departments at all relevant district and state workshops. For small departments in rural schools, such as the science department at S3, the only way to satisfy the district policy is for all three teachers to take turns representing the department. The individual representing the department is then expected to report to the others at the next monthly meeting. Sometimes all three teachers come to department meetings with information on different workshops.

Occasionally S3's science teachers also discuss teacher assignments or other matters related to master scheduling. Although the principal makes all final decisions, teachers sometimes use department meetings to formulate recommendations. For example, as we discuss later, the math and science departments had both recently addressed what they perceived to be the counselor's failure to place low-achieving, unmotivated students in general track classes. They had previously raised this problem with the principal, at which point the principal asked teachers to make suggestions about ways to alleviate the problem.

The science department chair, one of two African American teachers at S3, had been chair for most of his 19 years at the school. His responsibilities include coordinating the department's small annual supply order, keeping the minutes for department meetings, representing the department at extra workshops if the other two science teachers are unavailable, and relaying information from the principal to the other science teachers. He said he also observes each science teacher once yearly. He said that conceivably a department chair might provide advice to teachers having difficulties, but his teachers had never required such assistance.

Instructional Resources

All students receive textbooks free of charge. Also, unlike District A, District B has a policy against student fees for classes. Thus students at S3 never find themselves having to spend the first part of the school year without a textbook because they cannot come up with the money needed for fees.

In addition to textbooks, teachers frequently use mimeographed or photocopied material for classroom instruction. The principal said that duplicating paper accounts for the lion's share of the school's supply budget. In addition to textbooks and work sheets, teachers receive $200 per year (or $33 dollars per class) to purchase supplementary materials and supplies. Departments sometimes make special requests to the principal for special equipment or supplies. Occasionally the principal provides the extra funds.

The most impressive display of instructional resources we saw at S3 were in the Remedial Math Lab. This room contains seven computer stations that are linked to a central server. The server controls a basic skills drill and practice program produced by the Computer Curriculum Corporation (CCC). The package is one of a handful strongly recommended to schools by curriculum specialists from the state education agency. The CCC program aligns closely with the objectives covered on the state BSAP. Students work through the objectives at their own pace but are not allowed by the computer to proceed to a new objective until they master the one they are working on. The software program is also designed to generate practice tests that closely conform to the format of the state grade 10 BSAP math exam and to give teachers detailed printouts on students' performance on tests as well as daily work.

Remedial Math classes, thanks to additional compensatory education funding from the state, enjoy a lower student-to-teacher ratio than other courses. In a typical class, half the students begin working individually on the computers while the teacher introduces a new objective or concept to the other students. Halfway through the class the two groups of students trade places and the teacher presents her brief lesson once more to the students who have spent the first half of class at the computers.

In addition to textbooks and computers, the Remedial Math classroom brims with supplementary materials, things that are conspicuously absent in other math and science classrooms. At the time of our interview with her, the Remedial Math target teacher was also in the process of completing a large purchase order for manipulative instructional materials.

Another special resource allocated to the Remedial Math class is a full-time teacher aide. The aide spends all of her time supervising and assisting students as they work at the computers. Thus students waste virtually no time at the computers, and the teacher is able to concentrate fully on her lesson with the other students. With the low student-to-teacher ratio, a full-time classroom aide, a specially designed computerized instructional program, and supplementary instructional materials, Remedial Math classes at S3 benefit enormously from what is sometimes called the "Cadillac" approach to basic skills intensification.

There is a stark contrast in the allocation of instructional resources between the Remedial Math classroom and other math and science classrooms. The classroom used for Algebra II, Geometry, and PreCalculus was equipped with eight Apple IIe computers, but the teacher for those courses noted that she had little software and the computers were rarely used. She also said that the new 45-minute class periods did not permit enough time for students to do their regular work and still have time for the computers. This teacher's logs indicate that she used her computers in only 2 of the 131 lessons on which she reported for her Algebra II target class. Unlike the well-stocked shelves and bookcases in the Remedial Math classroom, the bookshelves in the classroom for advanced mathematics were barren.

In the year of our study the district sent a portable classroom unit to S3 to be used as a science lab. Prior to this, the only science lab facility at S3 was a small, poorly equipped room. The department chair said the room was so small that he could fit only half of the students from a typical class in there at one time. To reach the lab one was required to pass through the Biology classroom.

Because of the difficulties of managing students in two places, the disruption caused to the Biology class, and the poorly equipped nature of the facility, Physical Science classes had come nowhere near meeting the state requirement of 20% of class time in lab. The science chair related his perspective on the lab situation.

> They want quality education in South Carolina, but they don't want to pay for it. I mean, how can you teach a kid scientific information for today's science with prehistoric stuff. When I say prehistoric, I mean, when you walk into a modern lab, you don't see a lot of the little prehistoric gadgets. You see analytical balances instead of the old hand, triple. So, in other words, we are trying to kill a duck with a sling shot instead of a shotgun.

Given that the district had added a new portable classroom for science labs and provided some new equipment and supplies for 1990-91, the target teacher for Physical Science said he expected to come closer to meeting state regulation than he had in the past. He said that the smaller class sizes accompanying the new seven-period day made it easier to conduct science labs, but at the same time reducing class periods to 45 minutes made labs more difficult.

The CP Biology teacher expressed deep frustration with the lack of lab experience her students brought with them to her classes. She quickly added, however, that the Physical Science teacher was not to be blamed for her students' lack of exposure to lab settings and procedures. Given the lack of adequate lab facilities and supplies in years past, the Biology teacher had all but monopolized the small lab area adjoining her classroom.

The inequity in funding for math and science at S3 is largely a function of state policy. The state BSAP covers only reading, writing, and math, and the state gives substantial sums to districts to intensify basic skills instruction and remediation in these subjects. The way in which the principal allocated money won through the state's SIRP program further exacerbated funding inequities between math and science. As a result of higher levels of state funding, remedial math classes at S3 averaged 14 students. In science, class sizes had been as high as 35 in 1989-90 but, under deregulation, in 1990-91 were down to about 25.

Math and Science Curricular Control

Textbooks

In this district, textbook selection is done democratically. After teachers have had an opportunity to preview all the books on the state list, they are encouraged to vote for the text of their choice for the courses they teach. The only target teacher at S3 who does not use the district adopted text is the Remedial Math teacher. This teacher works mainly from the state BSAP manual for basic skills instruction. She had also used SIRP funds to buy supplementary material that she finds more suitable for her students. Her main objection to the district text for Remedial Math is that it is written at a grade 6 level. She believes students need exposure to more complex concepts and challenging problems to succeed on the grade 10 BSAP, which is designed to test students on material normally taught no later than grade 8.

The target teacher for Algebra II followed her textbook more closely than the others at S3. She attributed this to the fact that it was her first year with the text. In a December interview, she said she thought she would skip around in the text much more during second semester. The text contained more material than she would be able to cover, so some topics would have to be omitted. The CP Physical Science target teacher said he follows the order of topics in his textbook. However, due to the fact that S3's BSAP and Stanford-8 math scores had slipped in 1989-90, he was stressing the math much more than the chemistry for 1990-91.

Like the Algebra II and CP Physical Science teachers, the CP Biology target teacher covers topics in the order of the textbook. However, the CP Biology teacher is much more likely to skip whole sections of the text and spend up to several weeks at a time working from teacher-made exercises. If we treat the state BSAP manual for basic skills as the Remedial Math teacher's primary "text," along with the CCC computer curriculum, then she uses her primary text virtually every day. By comparison, teacher logs show the Algebra teacher uses her course text in 56% of her classes, the CP Physical Science teacher uses his text in 66% of his lessons, while the CP Biology teacher uses her text for only 48% of her target class lessons.

Both science teachers noted that science textbooks tended to use teacher demonstrations instead of encouraging hands-on lab experiences for students. The CP Biology target teacher in particular found this to be problematic, attributing her preference for lab work to the fact that she had worked in a lab for 15 years before going into teaching. She said her conversations with other science teachers had made it clear that her preference for lab work is in the minority.

The absence of a district curriculum guide has no effect on the target teacher for Remedial Math. For her, course content is driven solely by the "T & T" manual (*Teaching and Testing Our Basic Skills Objectives*), a state document designed to help schools increase basic skills achievement. If a concept is covered in the T & T manual but not in the textbook, supplementary materials, or the computerized instruction package, the Remedial Math target teacher adds it. If something in the computer package or other materials does not correspond to an objective specified in the T & T manual, she skips it.

Other teachers receive little guidance from the state or district regarding course content. The math chair said her department had written up course outlines in the past, but they were in the process of revising them because most courses had changed textbooks. The new guides were expected to specify important objectives for each course. They would also note where key objectives are addressed in textbooks and, for lower level math courses, which objectives correspond to those tested on the state's grade 10 BSAP exam.

In 1990, S3's principal also asked science teachers to supply him with a course-by-course outline of science course content. The outlines produced by the three science teachers merely list general topic areas covered, much like the course descriptions in the school's student registration handbook.

State and District Tests

State law requires schools to administer the state BSAP exam to grade 10 and the Stanford-8 to grades 9 and 11. Only math, reading, and writing are tested on the BSAP. The state only requires these areas on the Stanford-8 as well, but S3's district has made an independent decision to administer the full Stanford-8 battery including science. Other than this the district does no special testing.

We have already noted effects of the state testing program on course content in Remedial Math. The Remedial Math target teacher feels the BSAP is a fair, well-balanced minimum competency test and therefore does not resent having course curricula dominated by it. Nor does this teacher resent the relatively great amount of record keeping required by the state for students receiving BSAP remediation. She did observe, however, that the paperwork would be more onerous to teachers who lack the assistance of a full-time aide.

We also noted that the CP Physical Science teacher was following the principal's wish to increase the emphasis of math content in his classes for 1990-91, to compensate for low standardized test scores on math for 1989-90. This teacher was also adjusting his testing practices so that students would get more practice with a multiple-choice format. In commenting on the tension between taking the time to teach all concepts thoroughly at the expense of covering material likely to be on standardized tests, he said:

> If need be, wherein I'm going to just teach for a test, if we are being pressured by the county or by my principal as to get in certain types of concepts so that we look good on the standardized tests, and I'm not saying that we study the test, but we think about ways that we can increase our scores so that we can be competitive. Yes, I wouldn't mind trying to adjust and go to something different.

The target teacher for CP Algebra II also felt pressured to spend significant time on BSAP objectives. In most schools, Algebra II is the third course in the CP math sequence, following Algebra I and Geometry. However, at S3, Algebra II is typically taken before Geometry. This created considerable anxiety for the Algebra II teacher. Although it was rare for an Algebra II student to have difficulty passing the grade 10 BSAP, she spent some time on BSAP objectives in the spring of each year just to guard against such a disaster. In the urban South Carolina district, where the vast majority of Algebra II students have already passed the grade 10 BSAP, Algebra II teachers pay virtually no attention to BSAP content.

The target teacher for CP Biology reported that she had looked at the state list of BSAP objectives and that they had little effect on her CP Biology course. She mentioned that she was somewhat concerned with the low scores S3's students had gotten on the science section of the Stanford-8 exam in 1989-90. She said that it would be difficult for an individual teacher to make much progress toward raising science scores because test items range over so many topics and courses.

Both the CP Algebra II and CP Biology teachers also mentioned the SAT as having a significant influence on course content. Their desire to increase SAT scores probably reflected state influence, as well as their own desire to see students qualify for admission to good colleges, and the principal's interest in having respectable scores. In both classrooms, we noticed instructional materials from the state department of education program designed to increase SAT scores. Among the materials was a wall calendar that gives two SAT-like multiple-choice practice test items for each day of the week.

Professional Development

Professional development activities for teachers at S3 are of four types: school inservice, district inservice, regional and state inservice, and continuing education. School-led inservices are the least likely to affect course content. Five of the seven and one-half school inservice days per year are set aside as teacher work days. S3 usually devotes one of the two and one-half remaining days to meet and discuss the previous year's BSAP and Stanford-8 scores. These meetings are initiated by the principal who uses them to focus faculty attention on areas of test performance that need improvement. Faculty sometimes help devise strategies for improvement, but often the principal simply informs them of new school policies that they will be held accountable to.

For 1990-91, the principal informed teachers that each department was responsible for conducting one workshop with the entire school faculty. These workshops occupied all of the remaining school inservice time. The four target teachers we interviewed agreed that most of these had been a waste of time. The science teachers mentioned that they had received positive feedback about the workshop they conducted on how to care for students experiencing an epileptic seizure. Apparently there were several epileptic children in the school and the science teachers, two of whom were trained emergency medical personnel, had decided the faculty should know how to respond to seizures.

Teachers also spend at least two and one-half days per year in district or state inservices. Teachers are somewhat more positive about the usefulness of district and state inservices than they are about the ones carried out at the school. Workshops conducted at the district level and attended by target teachers from S3 include topics such as graphing calculators and manipulatives for high school mathematics, using computers in the classroom, computer software for classrooms, new approaches to high school geometry, planning botany field trips, science experiments and labs, dropout prevention, and teacher evaluation.

Science target teachers for S3 also attended the state science teachers' convention at district expense, and the target teachers for math attended the meetings for the state chapter of NCTM. Each teacher spent two days at these workshops and found them most valuable. Topics for other state workshops attended by S3 target teachers include the state Teacher Incentive Program and the state program for school deregulation.

Teachers seem receptive to the state's continuing education requirement of six credit hours of college course work in one's subject area for each five-year period. The district offers two courses per semester at the district office by working with college professors who are willing to conduct the course, so that teachers do not have to make the two-hour round trip drive required to reach the nearest college. Many of these courses are offered to teachers free of charge, as funding for them is provided through the federal Eisenhower math and science program. Several teachers expressed appreciation for the way that the state and federal government worked with the district to make continuing education convenient and inexpensive.

S3's CP Physical Science target teacher was an important exception to the rule that teachers usually rely on the district, state, and colleges for professional development activities. The summer before we interviewed him, this teacher had attended an intensive 2-week workshop, sponsored by the DuPont Corporation, on teaching Physical Science. To attend the workshop, teachers were required to submit applications describing how they expected the workshop to change their own classroom practice. The focus of the workshop was on lab activities that emphasize conceptual aspects of physics, not mathematics. Teachers attending the workshop spent mornings in the classroom and afternoons in the lab. Although S3's Physical Science teacher did not appear to be doing more labs as a result of the workshop, he did say that the conceptual approach to physics emphasized in the workshop influenced how he explained ideas to low-achieving students in his classes.

In addition to the DuPont workshop, S3's Physical Science teacher had also attended workshops with representatives of DuPont, Duracell, and General Electric on advising students about careers in science-related fields. Each company offers scholarships for minority students pursuing science majors in college. Most of the scholarships include summer job internships, which the companies use as a basis for recruiting the students to come to work for them following college graduation.

Teacher Evaluation

Teacher evaluation is a topic of considerable interest to teachers at S3 as a result of the district's decision to pilot a new program for the state. In the new program, Consensus-Based Evaluation (CBE), teams consisting of three evaluators make at least two visits to a teacher's classroom before writing a joint evaluation report. Preceding classroom observations, the CBE team meets with the teacher to review the teacher's student records, course outlines, and timetables for coverage of course content. There is a postobservation review of results as well. Fourteen of S3's teachers were slated for CBE evaluation the year of our study. The two target teachers undergoing CBE were each observed three times.

The content of CBE evaluations is based on the PET (Program for Effective Teaching) instrument recommended by the state for teacher evaluation. PET, a product of effective schools research of the 1980s, is oriented almost entirely to pedagogy, not content. All teachers in S3's district are required to receive training in PET. Several teachers, including the target teachers for Remedial Math and CP Physical Science are PET teacher trainers. The Remedial Math teacher is also a CBE evaluator, along with the principal.

Teachers find CBE to be highly obtrusive. They say it is distracting to students as well as themselves to have three adults sitting in the back of the class. Meeting with the CBE team before and after the observations also adds to the amount of time a teacher must devote to being evaluated. However, the evaluation system prior to CBE had required the same number of classroom visits as well as one conference between the teacher and evaluator.

It is also possible that teachers were feeling the combined effects of CBE and other forms of evaluation. As noted earlier, the new superintendent for S3's district required principals to conduct five informal observations daily, one of which must be at least 30 minutes long. Written results of observations had to be submitted weekly to the superintendent. Teacher logs for S3 show that the target teacher for CP Algebra II (who missed 50 school days due to illness) was observed by the principal 8 times, the Remedial Math teacher was observed 12 times, the CP Biology teacher was visited 14 times, and the CP Physical Science teacher was seen by the principal for 6 informal observations.

S3's principal was the biggest critic of teacher evaluation. He disliked the CBE program "because two of my best teachers are gone all the time to evaluate teachers around the district." As a CBE evaluator, he was in the same predicament. He feared that achievement might suffer in the CBE evaluators' classes, and that he himself was not spending as much time as he should at his own school. The principal also felt CBE entailed too much classroom observation. Of course, CBE involved only a fraction of the observations mandated by the district superintendent, but the principal said he would much prefer to do fewer of these too.

Teachers who apply for state Teacher Incentive Program bonuses under the "Individual Plan" experience an additional round of evaluation by state officials. This evaluation is based primarily on a document called the Student Achievement Proposal, with some attention also given to student work portfolios. Aspiring TIP recipients file Student Achievement Proposals with the state by the end of the first quarter of the school year. If accepted by the state, the student achievement goals specified in the proposal become the main basis for determining at year's end whether the teacher has produced exceptional achievement gains.

Below is the entire Student Achievement Proposal the state accepted from S3's CP Physical Science teacher for his Period 3 class, our log class for RUC.

> Based on my experience and the characteristics of these students, I would normally expect 77% of these students to achieve a final grade of 70 or better in this course. Superior student achievement will be demonstrated if more than 77% of my students achieve a final grade of 70 or more in this course.
>
> Only those students included in the statistics documented below will be considered in my final evaluation [i.e., students entering the course late will not be included]. Furthermore, any student with excessive absences, 10 or more, will be excluded from my year-end evaluation.
>
> Baseline data for this class consists of test grades from teacher-designed tests, textbook-designed tests, and homework grades. The grades have been collected from 8/90 to 10/4/90.
>
> Grade Distribution
> 90-99 = 3
> 80-89 = 3
> 70-79 = 8
> 55-69 = 8
>
> Student achievement is evaluated by performance on teacher-designed tests, textbook-designed tests, homework, oral quizzes, a science project (optional), and a nine-weeks exam. Grades are derived as follows: tests, quizzes, and nine-weeks exam = 40%; homework, written assignments, current science skill-builders, and classroom participation (activities and labs) = 60%.
>
> A summary of Physical Science grades for the entire 1990-91 school year will be provided to show evidence of superior student achievement. Examples of tests, quizzes, and exams will also be available.

The Physical Science teacher's TIP proposal was later rendered irrelevant, as the state appropriated no funds for TIP for 1991. The math department chair (and target teacher for CP Algebra II) said she refused to apply for TIP even though she was wholly confident that she would compete successfully. She saw the program as a sham, stating that virtually any teacher could, and some did, "put on a good act," underestimating student performance at the outset or exaggerating it in the end.

Other Curricular Influences

State EIA policy, including the SIRP, TIP, and PIP programs, has perhaps greater influence than any other factor on curriculum policy at S3. However, such impact is far from automatic, as seen in the case of District A's schools, S1 and S2. Except for a handful of schools that perform so poorly as to be deemed "educationally impaired" (see in Part I, Sanctions in EIA Policy), schools incur no particular penalty for basically ignoring most of the EIA policies to which administrators and faculty at S3 were extremely attentive. Although the state provides incentives to encourage schools to improve academic achievement, principals and teachers themselves, collectively and individually, ultimately decide what level of resources and effort they will invest in pursuing extra state funds. In fact, with the important exception of the state's basic skills instruction manual, the state is not at all prescriptive about how schools should organize themselves to optimize competitiveness for SIRP, TIP, and PIP bonuses. In view of the great range of discretion left to schools by the state, we discuss the role of EIA policy at S3 in the section on Distinctive School Practices.

Course Sequences in Math and Science

S3's principal estimated that students were evenly divided among the tracks. The department chair for math estimated that about 35% of all students start out in the college-prep track, and that as many as 5% more transfer to the CP track before starting grade 10. However, after grade ten, she said, there is substantial attrition from the CP track.

The district has no formal policy on standard course sequences, but it requires that schools adopt course sequences that enable students to meet state graduation requirements and CP students to qualify for college admission. General track students typically take General Math I, General Math II, and General Math III to satisfy the math requirement, and Physical Science and Biology to meet the science requirement. Many general track students graduate with CP Physical Science, and some with CP Biology on their transcript, having taken those courses before transferring to the general track for grades 11 and 12. The science chair and target teacher for CP Physical Science estimated that 60% of the school's grade 9 students were enrolled in CP Physical Science for the year of our study. College prep students typically take CP Algebra I, CP Algebra II, CP Geometry, and CP Algebra III (Precalculus). A small number of students take CP Algebra II and CP Geometry simultaneously in grade 10 so that they can take calculus as seniors. In science, college prep students typically take the CP level of Physical Science, Biology, and Chemistry in their first three years. Twenty of 113 seniors at S3 took Physics in the year of our study.

The principal reports that about 30% of S3's graduates go on to some form of postsecondary schooling, including technical school and two-year community colleges as well as four-year colleges and universities. The counselor reports that very few General Track students continue to postsecondary schooling.

Course Selection Process

S3 has one guidance counselor for 500 students. In addition to advising students on course selection, college admissions, and personal problems, the counselor is in charge of cumulative student records, master scheduling, and coordination of testing for various state and district tests, as well as tests requested by teachers (e.g., tests pertaining to special education students), and students (e.g., tests required of students who wish to enroll in the armed services).

The counselor points to her heavy work load and the high student-to-counselor ratio in describing the streamlined course selection process for entering freshmen. The process begins each spring when the counselor meets with eighth-grade students from the town's middle school. At this meeting, the counselor informs students of high school graduation and college entrance requirements, describes the array of courses offered in the high school's curricular tracks, notes the options for grade 9 (e.g., students may choose between General Math I and CP Algebra I, unless referred for math remediation, and between General Physical Science and CP Physical Science). She then leaves students with a booklet containing brief course descriptions and an outline of the high school program. Students are told to share the information with their parents, then complete and return the course selection form included with the booklet. The course selection form has a place for students to indicate which curricular track they wish to be in and six lines on which to enter the names of the courses they wish to take. The student's signature is also required on the form, but not that of a parent or guardian.

Similar meetings are held with students in grades 9, 10, and 11. Continuing high school students receive the same booklet and course selection form given to entering freshmen.

Course Selection Criteria

RUC science target teachers were engaged in open conflict with the guidance counselor at the time of our field work. Like the science teachers at District A's S1 High, S3's teachers felt that too many students were inappropriately enrolling in CP courses. For the year of our study, the school had four classes of CP Physical Science and three classes of General Physical Science. In Biology, there were three classes each in the general and college tracks. In math, general track classes for freshmen (i.e., General Math I and Remedial Math I) outnumbered CP Algebra I classes, seven to four. The two Remedial Math I classes were composed entirely of students who failed to demonstrate mastery on the math portion of the grade 8 BSAP exam. Thus, the state mechanism that precludes students with low mathematics achievement from selecting college-prep math courses seemed to account for the preponderance of general track math courses at S3. Conversely, the absence of any state policy regarding course placement for science resulted in many low-achieving students selecting CP coursework in that subject.

The CP Physical Science teacher reported that about half of those in CP classes should have been in General Physical Science. He believed that the counselor had placed students in Physical Science classes according to alphabetical order. The CP Biology target teacher said that she had twenty CP Biology students who were simultaneously enrolled in Remedial Reading, something she considered preposterous. Upon seeing her class rosters at the beginning of the school year, she went to the counselor "fuming mad" and produced a list of the remedial reading students. She then demanded that they be transferred at once on the grounds that they were certain to fail the course and slow down the able students. The counselor responded by noting that she had no choice but to honor students' and parents' decisions in view of a state law that gives parents ultimate control of their children's program of study. In any event, said the counselor, the school master schedule lacked the flexibility to transfer such a large number of students at such a late date. The counselor suggested the Biology teacher resolve the situation herself, either by making the course easier or by "dropping hints" to low achievers by making the first few tests of the year particularly difficult.

The Algebra II teacher did not have as many problems with course placement because few students who are not serious about academics elect advanced mathematics courses. Nevertheless, she felt a broad range of students take Algebra II. In the year of our study, by prior arrangement with the principal, she had organized her three Algebra II classes (not the target class for RUC) so that one class was composed entirely of high achievers. This permitted her to cover more material more thoroughly with those students she believed to be most capable of rigorous work.

Eventually, the CP Biology and Physical Science teacher, along with other faculty, succeeded in convincing the principal to instruct the counselor to transfer some of the lowest achieving students out of CP courses. The counselor reported that the transfers affected about 5% (50) of the school's students. The transfers went smoothly, with two exceptions. One student, a sophomore, had enrolled in Algebra II, even though he had taken and done poorly in Prealgebra in grade nine. He and his parents would not consent to transfer him from the class despite the teacher's prediction of almost certain failure. Another student's parents refused to remove her from CP Biology because she wanted to stay with her friends. This student was failing the class and, according to the teacher, had standardized achievement scores in the bottom quartile for the state. The principal declined to pursue these cases further on the grounds that the parents would prevail on appeal to the district school board.

Although the teachers could not make all the changes they desired for the year of the study, they had begun taking steps to establish prerequisites and other criteria for enrollment in college-prep courses for the next school year. For example, they were preparing to go before the school board to request approval of a policy requiring all students to follow the school's standard course sequence and to earn a "B" or better in each course to qualify for continuation in the sequence. They believed board approval of such a policy would give the counselor the authority needed to change the course placement process.

As for the counselor, she did not dispute the teachers' position that many students were in the wrong track. Even after transferring 5% of the student population to the general track from the college-prep track, the counselor herself estimated that an additional 5 to 10 percent were in "over their heads" in CP courses. She attributed overenrollment in CP courses to two factors. First, college-prep course enrollment had risen considerably at S3 following the implementation of higher college admission requirements under EIA. Prior to the new requirements, the school had to push students to take CP courses.

The other problem, according to the guidance counselor, is that too many of S3's students are lazy. She said that white students are especially prone to enroll in CP courses simply to be with their friends, not because they value rigorous academic courses. White students also seemed to account for more than their share of discipline problems. She concluded by suggesting that many white students at S3 "suffer from a misplaced sense of entitlement," adding that the attitude was most pervasive among students from families that represent the "lower-class elements" of the white community. As for the black students, she perceived them to be much more eager to utilize the school as a tool for upward economic mobility and to leave the community upon high school graduation. For some this meant college-prep work, for others it meant acquiring vocational skills that would help them obtain well-paying jobs in urban labor markets.

Other teachers and the principal shared the counselor's view that many students were lazy and indifferent to academic knowledge. Although they did not explicitly state that the main problem was with white students, the way they described the situation seemed to imply as much. Teachers at S3 never used theories of cultural deprivation to account for low student achievement and negative attitudes toward school. This contrasts sharply with teachers at S1 who clearly used cultural deprivation theory to account for low achievement among their predominately African American students. S3 is at the opposite end of the spectrum from the other southern rural school in our sample, where black and white students continued to hold separate proms, and one teacher openly expressed his theory that "inbreeding" among blacks accounted for what he perceived to be "low intelligence" among his black students.

Perhaps one reason teachers at S3 did not espouse the theory of cultural deprivation is that African American students tended to hold their own in comparison with white peers. Examination of teacher questionnaire data on the racial composition of 14 math and science classes at all levels suggests that blacks and whites were distributed across general and CP courses roughly in proportion to their numbers in the school as a whole. Deviations from this generalization occurred in Remedial and General Math, where blacks were slightly overrepresented; Algebra II, where blacks were highly underrepresented; and CP Chemistry and Physics where blacks were highly overrepresented.

Distinctive School Practices

School policy and organizational culture at S3 are profoundly shaped by the EIA. The principal and faculty aggressively pursued extra state funds under the EIA's three main incentive programs, SIRP, TIP, and PIP.

S3's principal characterized the EIA as "the biggest boost to academic achievement [S3] ever got." Initially, faculty were highly supportive of the BSAP high school exit exam and cash incentives; that morale and enthusiasm had diminished during the year of our study because the school had failed to win SIRP and TIP incentives for the first time in four years. The principal also recognized that competing for SIRP, TIP, and PIP awards put the faculty as well as himself under a lot of stress. This stress was reinforced by the state practice of publishing achievement test scores for examination by the media and the public. According to the principal,

> In South Carolina, there is a lot of emphasis placed on test scores. And they come out in the paper, and they rank schools, you know. I don't feel there should be that much emphasis on test scores, but that's the report card, and that's the way it is. If they're not up to par, you're going to get criticized for not doing your job.

The willingness of the principal and faculty to accept the elevated importance of test scores under the EIA was the first step toward becoming competitive for incentive dollars. The second step was to reexamine and alter traditional school practice to maximize test score gains.

The freshman class of 1986 was the first group affected by the EIA requirement that all students pass the grade 10 BSAP to receive a high school diploma. SIRP was also implemented, using BSAP and CTBS scores from previous years for baseline data, and TIP and PIP were piloted in several districts, including S3's. S3's initial strategy for competing for incentives focused on revamping Remedial Math and Remedial Reading and Writing classes. For Remedial Math, the principal recruited a highly successful middle school mathematics teacher to take responsibility for improving achievement among low achievers in the high school. The principal emphasized that improving math achievement was to be given high priority, as reflected by the decision to hire a full-time aide for Remedial Math and to purchase new computer hardware and software for the class.

Other teachers were affected as well. The principal began monitoring all teachers to insure that they were doing everything possible, especially in classes serving primarily freshmen and sophomores, to raise basic skills achievement in math, reading, and writing. For the first time teachers had to establish long-range goals for student performance and keep records on remedial instruction provided to students at all grade levels who scored poorly on math, reading, and writing.

S3's coordination and intensification of basic skills instruction paid off in Spring 1986 as the school took home its first SIRP, TIP, and PIP awards. The principal invested the bulk of the $25,000 SIRP award in the school's mathematics program to maximize the odds of winning again in 1987. It was at this time that the Remedial Math teacher began investing heavily in supplementary curricular materials, and mathematics classrooms were equipped with Apple IIe computers. The principal also used SIRP funds to give free passes to athletic events and other school functions to all students who scored 70% or better on the BSAP (or at a comparable level on the CTBS, or Stanford-8). These students also received free T-shirts with a message designating them as ones who had contributed to the school's effort to improve academic performance.

In Spring 1987, S3 won SIRP, TIP, and PIP awards once again. This time it was the language arts program that benefitted most from the SIRP bonus. Almost all the money was used to purchase computers and software for the Remedial Reading lab. Once again, the principal had funneled resources into a subject targeted by state tests and, thus, the SIRP, TIP, and PIP programs.

In Fall 1987, the principal devoted one day of school inservice to a meeting of the full faculty for the purpose of discussing the previous year's test scores and making strategies for winning again in the upcoming year. At this time he announced that future SIRP awards would be used throughout the school, not allocated entirely to math and language.

In Spring 1988, S3 once more received SIRP, TIP, and PIP awards. However, because the average daily attendance rate for teachers and for students had slipped below the 95% level, the school's SIRP award was not as large as it had been in the previous two years. The state withholds 20% of a school's SIRP award for each of these infractions. Also, teachers who miss work more than five percent of the time forfeit their TIP bonuses.

As a consequence of the smaller award amount, most of the funds were once again consumed by math and language, while departments such as science continued to operate on meager resources. The principal also introduced a new policy to restore teacher attendance to the 95% level. In 1988-89, he would personally place phone calls to check up on teachers taking sick days.

S3's winning streak was broken in Spring 1989, despite the fact that the average daily attendance rate for teachers was back up to 97.4%, and students weighed in with raw test scores comparable to those of 1988. In surveying the situation, the principal and others realized that S3 had been losing ground to other schools, even as their raw test scores were climbing. In fact, S3's state percentile rank on the grade 10 BSAP exam had slipped from 40, to 35, to 31 as their average raw score moved from 736, to 753, to 752 for the years 1986-1988. The main reason S3 won SIRP awards for this period is that they had gotten an especially quick start on basic skills intensification relative to other schools of comparable socioeconomic status. By 1989, S3 had topped out, while schools that had previously lagged behind began to produce strong gains.

The principal and faculty were extremely disappointed about not winning the state awards for 1989. The news that they had competed unsuccessfully was followed by a period of discussion in which everyone looked for explanations of why they had come up short and what they could do to recover in the coming year. The Remedial Math teacher was naturally a key player in this discussion because she was recognized and respected as the one person who had contributed most to the school's previous success. It was therefore disconcerting to faculty when the Remedial Math teacher told them that she had done all that she could. She had taken the Remedial Math job in a school where only 45% of all students in grades 9, 10, and 11 had passed the BSAP the first year it was administered. Now 85% passed on their first attempt and 95% passed before regularly scheduled graduation. She recounts a discussion she had with the principal.

> We didn't get the money this year, I'm sure [the principal] told you so. It's very depressing. But it's like I told him, when he was giving [the remedial reading teacher] and I a hard time. And I started laughing, and I said, "That's fine, but you look at how many of our students met standard. That's not where your problem is. Your problem is in the middle of the road. The reason you didn't get the money is because your middle people didn't improve."

Large numbers of students were topping out on the BSAP exam. Further test score gains would have to come on the Stanford-8 and involve a larger segment of the student population than had been affected by basic skills intensification strategies.

It appeared that the Remedial Math teacher's prognosis of the challenges facing the school in its pursuit of incentive funds had made an impression on other faculty. In Fall 1990, S3 switched from the TIP Campus Plan to the Individual Plan for the first time. This change reflected teachers' belief that the school was not likely to win a SIRP award, so only individuals were going to be competitive for TIP. The 1990-91 school year also saw increased faculty concern with the performance of nonremedial students, especially college-prep students.

Teachers at S3 never suggested that the increased attention to issues surrounding course placement and student performance in college-prep courses was related to the school's experience with BSAP and the EIA incentive programs. However, given the timing of events, we believe EIA was an important part of the explanation. The BSAP program, due to its success in improving basic skills achievement, had brought the school to a new juncture. The desire to win SIRP and TIP funds remained, but the school's previous strategy for competing had become obsolete. The question S3's faculty and administration faced at the time of our study was whether the experience and knowledge they gained in organizing curricula and instruction to improve basic skills achievement would provide insight into improving classroom practice across the curriculum or whether an entirely different approach would be needed.

Chapter 5

CLASSROOM PRACTICE: THE ENACTED CURRICULUM IN HIGH SCHOOL MATHEMATICS AND SCIENCE COURSES

This chapter presents what was learned about the nature of instruction in math and science courses in high schools serving high concentrations of students from low income families. Instruction is described in terms of both content and pedagogy. Two data sets are analyzed. One is based on questionnaire data; 166 mathematics teachers and 143 science teachers completed questionnaires describing the content and pedagogical strategies making up their instruction in a specific section of a specific course they taught. Every math and science teacher in participating schools was surveyed. Courses and sections were selected to provide maximum descriptive coverage of the entire math and science curriculum offered in each school (i.e., the sample included at least one section of each course offered in each department). As described in Chapter 2, the overall response rate for questionnaire data was 75 percent. The other source of data for describing content and pedagogical practices is the daily logs of instruction provided by the sample of target teachers. There were 32 math teachers and 30 science teachers for whom log data were available for the majority of days of instruction over a full two-semester period; the median number of daily logs per course description was 165.

The chapter is organized into two major subsections, one on content and the other on pedagogy. For the section on content, mathematics is described first; then science; and then a comparison between the two subject areas. The section on pedagogy follows the same organizational pattern. Throughout, descriptions are organized by individual course and by groupings of courses according to course type. In addition to these internal comparisons, descriptions of the enacted curriculum are compared against the standards of curriculum reform that seek to increase the amount of attention given to higher order thinking, problem solving, applications, and active learning.

The Content of High School Mathematics and Science

Teacher log data provide the most accurate, comprehensive, and detailed descriptions of the content covered in high school mathematics and science classes. The courses for which log data were obtained, however, are not representative of the entire course offerings in our high schools. Courses were selected because they experienced big enrollment gains following the state's establishment of increased high school graduation requirements. Thus, the log sample courses emphasize basic and intermediate level coursework over advanced coursework. In contrast, the questionnaire sample is representative of the entire curriculum offered, although not weighted by number of sections per course and with some oversampling of log sample courses. But, questionnaire data are based on both retrospective and prospective reports of teachers and were not designed to capture the same fine-grained detail as were the logs. Still, as seen in Chapter 2, concurrent validity between logs and questionnaire data is surprisingly high. Together the log sample and questionnaire sample provide the most accurate, detailed, and comprehensive description of high school science and mathematics ever assembled.

Mathematics

Mathematical topics: Dimensions A and B. Table 5.1 presents the proportions of instructional time spent covering content as described by Dimension A of the content taxonomy. Some might call the areas of Dimension A groups of content topics. In math, the Dimension A content areas are number and number relations, arithmetic, measurement, algebra, geometry, trigonometry, statistics, probability, advanced algebra/precalculus/calculus, and finite/discrete mathematics. Each row of Table 5.1 represents the distribution of instructional time over a full school year, as reported by one teacher for a specific section taught of the course as labeled. Courses are ordered from introductory and basic courses to intermediate and higher level courses, with all courses having the same course title grouped together. Each course is also identified by an identification that locates the course within the study design. In Table 5.1, the first course listed is identified by F1M1, meaning Florida School 1, Mathematics, First Target Teacher. Each state had three schools, with the first two schools coming from the urban district and the third school coming from the suburban or rural district.

For most rows in the table, the entries sum to 1.0 or 100 percent of instructional time. In rows where the proportions do not sum to 1.0, the amount less than 1.0 reflects the fraction of time that a teacher reported content not felt to fit in any of the content possibilities given in Dimension A. In all but a few cases, content reported as falling outside of the taxonomy was 0 to .01 (less than 1 percent). The one clear exception is S3M1, a computer based drill-and-practice remedial course designed to provide instruction to students having difficulty passing the state high school graduation test in mathematics. For that course, the 34 percent of the time reported as falling outside of the taxonomy represents time spent on computer drill software; virtually all of the computer time fits under the categories of number, arithmetic, and measurement in proportions comparable to the relative emphases shown across those three categories for that course. The entries in parentheses in Table 5.1 give estimates on Dimension A for S3M1 after allocating the computer drill time to the categories of number, arithmetic, and measurement.

Several patterns emerge from Table 5.1. The basic skills, general math, consumer math, and practical math courses emphasize number and number relations, arithmetic, and measurement almost exclusively, the two exceptions being the Florida basic skills class and the Missouri general math class, each of which put a higher emphasis on algebra, 21 percent for the Florida course and 30 percent for the Missouri course. Relative emphasis on arithmetic varied, but arithmetic was the single most emphasized content area for basic math courses.

Prealgebra courses put primary emphasis on arithmetic and algebra, though which of these two areas of content is emphasized most varies from course to course. Math A, a special California

Table 5.1

Content Variations Within and Between Course Titles: Math Dimension A

Course Location and Title	Number	Arith.	Meas.	Alg.	Geo.	Trig.	Stat.	Prob.	Precalc.	Discrete Math
F1M1 Basic Skills	.01	.68	.04	.21	.03	.00	.00	.00	.00	.00
F1M2 Gen Math	.02	.63	.24	.08	.01	.00	.00	.00	.00	.02
F3M3 Gen Math 2	.14	.42	.14	.08	.11	.04	.01	.00	.00	.03
S3M1 Gen Math	.16 (.25)[b]	.32 (.50)	.12 (.19)	.03	.02	.00	.00	.00	.00	.00
M1M1 Gen Math	.06	.50	.10	.30	.00	.00	.03	.00	.00	.00
C2M1 Consumer Math	.03	.89	.05	.03	.00	.00	.00	.00	.00	.00
C3M2 Mastering Math	.15	.70	.08	.01	.00	.00	.00	.00	.00	.00
M2M1 Practical Math	.12	.44	.25	.09	.02	.01	.01	.01	.00	.05
A1M2 Prealg	.11	.56	.11	.21	.01	.00	.00	.00	.00	.00
A3M1 Prealg	.03	.56	.09	.28	.02	.00	.00	.01	.00	.00
C2M2 Math A	.07	.06	.00	.48	.34	.00	.04	.00	.00	.00
F2M2 Prealg	.03	.31	.01	.60	.03	.00	.00	.01	.00	.01
M3M1 Prealg	.12	.20	.01	.56	.10	.00	.00	.00	.00	.01
A2M1 Alg 1[a]	.15	.23	.00	.61	.00	.00	.00	.00	.00	.00
P1M1 Alg 1	.02	.00	.00	.97	.00	.00	.00	.00	.00	.00
P1M2 Alg 1	.02	.03	.01	.89	.01	.00	.03	.00	.00	.01
P2M1 Alg 1	.08	.04	.00	.87	.00	.00	.00	.00	.00	.00

Table 5.1 Continued

Course Location and Title	Number	Arith.	Meas.	Alg.	Geo.	Trig.	Stat.	Prob.	Precalc.	Discrete Math
P2M2 Alg 1	.00	.08	.00	.92	.00	.00	.00	.00	.00	.00
P3M2 Alg 1[a]	.01	.09	.00	.87	.00	.00	.00	.00	.00	.00
A1M1 Alg 1	.06	.14	.00	.74	.05	.00	.00	.00	.00	.00
C1M2 Alg 1	.04	.02	.01	.89	.03	.00	.00	.00	.00	.00
F3M2 Alg 1	.19	.08	.02	.69	.00	.00	.00	.00	.00	.00
M2M2 Alg 1	.04	.12	.04	.80	.00	.00	.00	.00	.00	.00
M3M2 Alg 1	.04	.07	.00	.85	.03	.00	.01	.01	.00	.00
A2M2 Alg 2	.02	.09	.06	.71	.03	.09	.00	.00	.00	.00
S1M1 Alg 2	.02	.02	.01	.95	.00	.00	.00	.00	.00	.00
S2M1 Alg 2	.03	.03	.00	.94	.00	.00	.00	.00	.00	.00
S3M2 Alg 2	.03	.02	.00	.92	.03	.00	.00	.00	.00	.00
A3M2 Geo	.01	.01	.06	.04	.82	.03	.00	.00	.00	.02
P3M1 Geo	.02	.05	.01	.05	.84	.01	.00	.00	.00	.02
S2M2 Geo	.02	.03	.09	.13	.68	.00	.00	.00	.00	.05
S1M2 Precalc	.00	.01	.00	.18	.15	.31	.00	.08	.23	.03

[a] Required of all freshmen.

[b] Proportions in parentheses are estimates of instructional emphases based on allocating the computer assisted instruction (.34), which was not reported on Dimension A, to the appropriate levels of Dimension A based on analysis of the software.

bridge course stimulated by the California mathematics framework, is distinctive in its emphasis upon algebra and geometry, with only 6 percent of instructional time devoted to arithmetic and no instructional time devoted to measurement.

Algebra 1 courses look like algebra courses. In each Algebra 1 course, algebra is by far the most emphasized content area. The A2M1 algebra course, an Algebra 1 course in a school where all students were required to take Algebra 1, did have the least emphasis on algebra (.61) and gave significant attention to number and number relations and arithmetic. However, the P3M2 Algebra 1 course, also in a school requiring all students to take Algebra 1, spent 87 percent of instructional time on algebra. In contrast, the F3M2 Algebra 1 course, in a school where Algebra 1 was not required, spent only .69 of instructional time on algebra and gave significant coverage to number and number relations.

Of the four Algebra 2 courses, three gave nearly exclusive emphasis to algebra. The fourth Algebra 2 course spent 71 percent of the time on algebra, nearly 10 percent of the time on trigonometry and another 10 percent of the time on arithmetic. None of the four Algebra 2 courses spent any time on advanced algebra topics such as those included under precalculus.

The three geometry courses emphasized geometry, but gave modest attention to several other content areas. One geometry course gave 13 percent of instructional time to algebra and an additional 9 percent to measurement.

The one precalculus course studied gave most attention to trigonometry, 31 percent; second most attention to precalculus, 23 percent; but significant attention to algebra, geometry, and probability as well. That precalculus course presented by far the greatest range of content coverage of any course studied.

Table 5.2 moves from the course-by-course descriptions of Table 5.1 to an analysis of Dimension A content by course type. The first eight courses in Table 5.1 are labeled basic math in

Table 5.2

Dimension A Means and Standard Deviations by Course Type for Math Courses

Course Type	n	Number		Arith.		Meas.		Alg.		Geo.		Trig.		Stat.		Prob.		Precalc.		Discrete Math	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
Basic Math	8	.09	.063	.57	.185	.13	.075	.10	.101	.03	.037	.01	.015	.01	.012	.00	.005	.00	.000	.01	.020
Prealgebra	5	.07	.045	.34	.222	.04	.050	.43	.170	.10	.137	.00	.000	.01	.016	.00	.005	.00	.000	.00	.004
Algebra 1	11	.06	.060	.08	.065	.01	.012	.83	.107	.01	.018	.00	.001	.00	.010	.00	.002	.00	.000	.00	.002
Algebra 2	4	.02	.006	.04	.035	.02	.029	.88	.115	.01	.017	.02	.045	.00	.000	.00	.000	.00	.002	.00	.000
Geometry	3	.02	.003	.03	.016	.05	.042	.08	.052	.78	.087	.01	.015	.00	.000	.00	.000	.00	.000	.03	.018
Trig/Precalc	1	.00	.000	.01	.000	.00	.000	.18	.000	.15	.000	.31	.000	.00	.000	.08	.000	.23	.000	.03	.000
Total	32	.06	.055	23	.257	.05	.066	.50	.361	.11	.231	.02	.057	.00	.010	.00	.014	.01	.041	.01	.014

Table 5.2. The next five courses in Table 5.1 represent prealgebra in Table 5.2. The 11 Algebra 1 courses form a group as do the four Algebra 2 courses and the three geometry courses. The last group in Table 5.2 is the precalculus course by itself.

For each course type, Table 5.2 presents means and standard deviations for each level of Dimension A. From these course groupings, it is much easier to see that basic math courses are dominated by an emphasis on arithmetic, with an average proportion of time equal to .57 but a rather sizeable standard deviation of .185. Basic math courses on average give nearly equal emphasis to number and number relations, measurement, and algebra, with means of .09, .13, and .10, respectively. These four content areas, then, comprise virtually all of what is taught in basic mathematics courses regardless of the wide variety of actual course titles (as seen in Table 5.1).

The five prealgebra courses devote on average .43 of their time to algebra, their primary content emphasis. Arithmetic receives on average .34 of the content emphasis in prealgebra, but with a sizeable variance (standard deviation of .222). The geometry mean of .10 is misleading, as the large .137 standard deviation suggests. As seen in Table 5.1, only one of the five prealgebra courses, Math A, gave any serious attention to geometry.

The Algebra 1 and Algebra 2 courses clearly focus on algebra, with means of .83 and .88, respectively, and modest standard deviations of .107 and .115. Similarly, the geometry courses are dominated by an emphasis on geometry, with a mean of .78 and a standard deviation of only .087.

Tables 5.1 and 5.2 make clear what content is covered in basic math, prealgebra, algebra 1 and 2, geometry, and precalculus classes. Those tables also make clear what content is not covered. Statistics, probability, and discrete math, content areas that receive considerable emphasis in the NCTM *Curriculum Standards*, receive virtually no attention in 30 out of the 32 classrooms studied. The two exceptions are the precalculus course that devoted .08 time to probability and a practical math course in the Missouri urban district that devoted .05 time to discrete math. The particular subtopics of probability covered in the precalculus course are described later. The discrete math covered in the practical math course was limited to the single topic business math (interest, insurance, etc.). Perhaps it is understandable that probability, statistics, and discrete math receive little attention in algebra and geometry courses, but statistics, probability, and discrete math are especially appropriate topics for general math, consumer math, and practical math courses. They also are appropriate topics for inclusion in California's Math A course; in fact they are included in the syllabus. Yet even in those courses, probability and discrete math received no attention, and statistics was limited to only .04 of total instructional time in the Math A course.

From Table 5.2, the following can be seen:

Basic Math Courses--Arithmetic (.57), Measurement (.13), Algebra (.10) = .80

Prealgebra Courses--Arithmetic (.34), Algebra (.43), Geometry (.10) = .87

Algebra 1 Courses--Algebra (.83)

Algebra 2 Courses--Algebra (.88)

Geometry Courses--Geometry (.78)

Trig/Precalculus Courses--Algebra (.18), Geometry (.15), Trigonometry (.31), Precalculus (.23) = .87

In all but the Trig/Precalculus course, three or fewer levels of Dimension A are needed to account for .80 or more of the total content taught.

Dimension B of the content taxonomy breaks down each level of Dimension A into ten or so subtopics. Dimension B, then, provides the capability for describing course content in greater detail than was done in Tables 5.1 and 5.2.

For each course type, if a level of Dimension A received an average emphasis of .10 or more, a breakdown on Dimension B is provided. Dimension B means represent proportions of total instructional time, such that Dimension B means for a particular level of Dimension A and a particular course type sum to the Dimension A means as reported in Table 5.2.

The basic math course emphasis upon arithmetic consists primarily of arithmetic with whole numbers (.15, .164),[1] percents (.07, .053), fractions (.13, .069), and decimals (.12, .092). The measurement covered in basic math consists primarily of measurement concerning time (.02, .019), length (.02, .027), perimeter (.01, .016), area (.03, .028), and volume (.01, .016). Little or no attention is given to the measurement of angles, weight, mass, or rates. The algebra taught in basic math consists primarily of work with variables (.02, .039), expressions (.02, .021), and linear equations (.04, .063).

For prealgebra courses, the arithmetic taught is much like the arithmetic taught in basic math courses. Emphasis is given to arithmetic with whole numbers (.07, .068), fractions (.09, .078), integers (.06, .038) and decimals (.05, .053). The algebra emphasized in prealgebra courses is limited almost exclusively to only two of the nine Dimension B levels, expressions (.11, .071) and linear equations (.24, .079). These are two of the three types of algebra emphasized in basic math courses, although in prealgebra they receive substantially more time. The third type of algebra receiving attention in basic math courses, variables, received .02 of total instructional time for both basic math courses and prealgebra courses, but in prealgebra the attention given to variables was modest in comparison to the attention given to expressions and linear equations. These content descriptions are consistent with the view of prealgebra as half way between basic math and algebra.

Since the only prealgebra course to give more than passing attention to geometry was the Math A course in California, Dimension B means for prealgebra courses under geometry will not be given here. A later section gives special attention to the Math A course and to algebra courses in schools where algebra was required of all students. Math A geometry will be described in that section.

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[1] Here and elsewhere in this report, when a pair of numbers is reported in parentheses, the first number is the mean and the second number is the standard deviation.

The algebra taught in Algebra 1 courses consists of the following: expressions (.24, .148), linear equations or inequalities (.25, .099), nonlinear equations or inequalities (.05, .047), systems of equations of inequalities (.06, .039), exponents or radicals (.12, .101), and functions (.08, .159). Thus, in nearly doubling the fraction of total instructional time devoted to algebra from that seen for prealgebra, Algebra 1 gives considerable emphasis to six of the nine Dimension B levels under algebra. Prealgebra covered only two levels of Dimension B; even for one of those two levels, Algebra 1 courses gave twice as much emphasis as did prealgebra courses (expressions). Still, with almost exclusive emphasis given to algebra in Algebra 1 courses, important algebra topics of sequences/series and matrix algebra received essentially no attention.

Algebra 2 courses are even more exclusively targeted to coverage of algebra topics than are Algebra 1 courses. In the 88 percent of the time that is on average spent covering algebra topics in Algebra 2 courses, the coverage is broken down into subtopics as follows: variables (.05, .041), expressions (.24, .140), linear equations (.18, .065), nonlinear equations (.11, .116), systems of equations (.09, .016), exponents or radicals (.13, .061), and functions (.06, .042). In contrast to Algebra 1 courses, Algebra 2 courses placed heavier emphasis on systems of equations and nonlinear equations and less emphasis on linear equations. Even in Algebra 2 courses, matrix algebra receives little to no attention; the topic of sequences/series receives on average .02 of instructional time, with a standard deviation of .027.

The content taught in geometry courses is almost exclusively geometry (.78). The Dimension B subtopics emphasized are points, lines, segments, rays, angles (.07, .053); relationships of lines; relationships of angles (.17, .050); triangles and properties (.20, .039); quadrilaterals and properties (.10, .043); and circles (.08, .071). While these five of the possible ten geometry Dimension B topics received the greatest emphasis (aggregating to .63 of the total .78 emphasis upon geometry), three additional topics received more than cursory attention: similarity (.04, .034), solid geometry (.05, .042), and coordinate geometry (.05, .006). The topic that stands out as receiving essentially no attention is transformations, either informal or formal (.01, .014).

The precalculus course is quite distinctive in its content emphases. Although .18 of the time is spent on algebra, only .05 of the time is spent on linear equations while .09 of the time is spent on sequences and series, a topic receiving virtually no attention in Algebra 1 courses and only .02 of the time in Algebra 2 courses. The geometry covered in the precalculus course consisted almost entirely of coordinate geometry (.11). Of the trigonometry covered in the course, the most emphasized topic was trigonometric functions (.10). Content emphases for other trigonometry topics ranged from .02 to .05: trigonometric ratios, basic identities, Pythagorean identities, solution of right triangles, solution of other triangles, and periodicity, amplitude. The only trigonometric topic receiving no attention in the precalculus course was polar coordinates. In addition, the precalculus course used .08 of instructional time to cover probability. Of the nine levels of Dimension B for probability, however, only three of the most basic received any attention: events, possible outcomes, trees (.01); equally likely-relative frequency probability (.04); and simple counting schemes (.02). Empirical probability including simulations received no attention, nor did conditional probability. Nor was there any attention given to discrete or continuous distributions.

The Questionnaire Sample. Table 5.3 presents content coverage means and standard deviations on Dimension A by course type based on the questionnaire sample. Of the 168 mathematics teachers who completed a questionnaire, 150 (89 percent) had usable questionnaire data for Item 85 that asked teachers to describe their instruction in terms of Dimension A and B topics. As noted in Chapter 2, the referent for questionnaire descriptions differs from the log data in that teachers are to indicate content covered in only the first half of the school year (fall semester), while log data are for a full school year. Further, part of the questionnaire data are prospective, collected at the start of the school year, while the remainder are retrospective, collected midyear. Dimension A data also differ between the target and questionnaire samples in the way that proportion of instructional time is estimated. The proportion of time from log data is calculated from daily records of topics and emphasis codes. In the questionnaire data, however, proportions of instructional time are more crudely estimated. For each Dimension B topic, a teacher indicates whether the topic was not taught, taught less than two hours, taught two to ten hours, or taught ten or more hours. Thus, when aggregating across levels of Dimension B to create proportions of instructional time spent on levels of Dimension A, topics taught for relatively little time are overweighted, while topics taught a great deal of time are underweighted. These differences between the questionnaire sample and the log sample in how instructional time is estimated lead to some discrepancies between Table 5.2 and 5.3. Nevertheless, within course type there is considerable agreement between the two tables, suggesting that the target sample data is a fairly good representation of the much larger set of courses in those same schools.

For basic math courses, Table 5.3 questionnaire data reflect a much heavier emphasis on number and number relations (.30, .139) than was true for the log data (Table 5.2). This discrepancy is probably a combination of two factors. First, most if not all of the ten Dimension B levels under number and number relations are taught but not emphasized. Thus, the weighting problem noted above comes into play to give an overestimate of the fraction of instructional time devoted to number and number relations. The actual discrepancy between questionnaire and log data is large enough, however, to suggest that the larger questionnaire sample of basic math courses gives greater emphasis to number and number relations than did the target sample. For both target and questionnaire data sets, the most emphasized content in basic math courses is arithmetic (with a mean of .33 and a standard deviation of .132 in the questionnaire sample). Measurement (.19, .130) and algebra (.07,

Table 5.3

Questionnaire Sample Means and Standard Deviations by Course Type for Math Courses

Course Type	n	Number		Arith.		Meas.		Alg.		Geo.		Trig.		Stat.		Prob.		Precalc.		Discrete Math	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
Basic Math	50	.30	.139	.33	.132	.19	.130	.07	.096	.05	.067	.01	.048	.02	.038	.01	.029	.01	.030	.01	.031
Prealgebra	13	.24	.134	.25	.164	.16	.120	.18	.161	.07	.097	.01	.023	.03	.062	.04	.057	.00	.016	.02	.034
Algebra 1	25	.28	.101	.29	.106	.07	.067	.30	.167	.03	.046	.01	.031	.00	.011	.00	.008	.01	.019	.01	.011
Algebra 2	20	.18	.114	.16	.132	.08	.071	.37	.244	.05	.073	.06	.074	.00	.000	.01	.035	.08	.136	.01	.015
Geometry	14	.11	.120	.09	.089	.16	.125	.13	.126	.39	.251	.07	.121	.00	.013	.00	.009	.00	.000	.05	.106
Trig/Precalc	12	.05	.064	.11	.105	.09	.065	.15	.101	.10	.088	.30	.270	.01	.012	.03	.061	.14	.145	.02	.042
Calculus	6	.04	.037	.04	.034	.05	.061	.14	.072	.11	.084	.23	.166	.00	.000	.00	.000	.36	.222	.03	.046
Not Grouped	10	.20	.142	.15	.198	.11	.102	.18	.081	.09	.098	.06	.114	.03	.072	.00	.013	.11	.133	.07	.174
Total	150	.22	.147	.23	.160	.13	.115	.18	.178	.09	.141	.06	.131	.01	.036	.01	.033	.05	.115	.02	.061

.096) also receive coverage in the questionnaire sample, as seen in Table 5.3, and these numbers agree fairly well with the target sample data in Table 5.2.

For prealgebra courses, number and number relation (.24, .134) is more emphasized in the questionnaire data than for the target sample, as is measurement (.16, .120). The two most emphasized levels of Dimension A in the target sample, however, are also among the most emphasized levels of Dimension A in the questionnaire sample: arithmetic (.25, .164) and algebra (.18, .161).

For the questionnaire sample, Algebra 1 courses are dominated by algebra (.30, .167), but because of the truncated way in which time was estimated from the questionnaire sample, algebra content nowhere near dominates Algebra 1 coverage in Table 5.3 to the extent it did in Table 5.2. Similarly, the questionnaire data show heavier emphasis on arithmetic and number and number relations content than did the target sample data, a finding almost surely explained by the weighting problem noted above. Most levels of Dimension B under number and number relations are covered, but for a relatively modest amount of time. Patterns for Algebra 2 hold similar to those for Algebra 1.

Geometry courses are dominated by coverage of geometry (.39, .251). Trig/precalculus courses are dominated by coverage of trigonometry (.30, .270). These findings parallel those for the target sample. The six calculus courses in the questionnaire sample are similar in content coverage to the trig/precalculus courses, with the exception that precalculus becomes the dominant emphasis (.36, .222).

Table 5.3 confirms on a much larger number of courses than in the target sample the finding that topics of statistics and probability receive little to no attention. The questionnaire total sample mean and standard deviation for statistics are .01, .036 and for probability .01, .033. Only in prealgebra was this general pattern of no coverage of probability and statistics challenged. For prealgebra, statistics and probability combined received .07 of total instructional time. For basic math courses, however, even in the larger questionnaire sample only .03 of instructional time was spent on statistics and probability combined. Similarly, discrete mathematics received relatively little attention for most course types. The ten residual not grouped courses in the questionnaire sample did have a mean of .07 and a very high standard deviation of .174 for coverage of discrete mathematics. This nonzero mean for discrete mathematics comes almost entirely from a single course, P1M3 Introduction to Computers. P1M3 allocated .56 of instructional time to discrete mathematics. For P1M3 the Dimension B discrete math topics emphasized were logic, business math, and development of computer algorithms. The .56 proportion of instructional time for discrete math is misleading for this teacher and course, however, because the teacher indicated the bulk of instruction was not included in the Dimension A and B choices provided by Question 85. That Dimensions A and B do not provide a good language for describing a computer course is no surprise; the taxonomy was developed for describing mathematics.

Required courses and Math A as described by Dimensions A and B. Of the 32 mathematics target courses, two of the Algebra 1 courses were in schools where Algebra 1 was required of all students. These two courses, then, become excellent instances for studying whether or not such standard setting results in a watered down curriculum. As was already seen in Table 5.1, in comparison to the average for all Algebra 1 courses, A2M1 put less emphasis on algebra (.61) while P3M2 was just above the average in its emphasis upon algebra. In the case of A2M1, the lower emphasis on algebra was replaced by a higher emphasis on number and number relations (.15) and arithmetic (.23). Table 5.4 provides a breakdown for the two courses in the particular types of algebra each emphasized. For comparative purposes, Table 5.4 also presents means and standard deviations across all eleven Algebra 1 courses. In the case of A2M1, Table 5.4 facilitates the identification of particular types of algebra sacrificed by the attention given to number and number

Table 5.4

Algebra 1 Courses Required of All Students: Algebra Dimension B Content Emphasis Comparisons

Course	*n*	Alg.		Var.	Exp.	Linear	Non-linear	Systems Equa.	Exponents Radicals	Series	Function	Matrices
A2M1	1		.61	.03	.20	.22	.03	.12	.02	.00	.00	.00
P3M2	1		.87	.03	.36	.24	.12	.02	.07	.00	.02	.00
Algebra 1	11	$\bar{X}$	.83	.02	.24	.25	.05	.06	.12	.00	.08	.00
		s	.107	.037	.148	.099	.047	.039	.101	.002	.159	.001

relations and arithmetic. Clearly it was the subtopics of exponents/radicals and functions that gave way to number and number relations and arithmetic in the A2M1 course. There are, however, some data that run counter to the conclusion that A2M1 is a slightly watered down version of Algebra 1. In A2M1 nearly twice as much instructional time was devoted to work with systems of equations than was true for the 11-course sample of Algebra 1 courses (.12 versus .06), a difference of more than two standard deviations. Content emphases for the other levels of Dimension B are essentially identical between A2M1 and the means of the 11-course sample. While the picture is a bit mixed but pointing in the direction of some watering down in the case of A2M1, P3M2 is a clear example of standards being held despite the requirement that all students take the course. Functions do not receive quite as much attention as in the general sample (.02 versus .08), but nonlinear equations receive substantially more attention (.12 versus .05), as do expressions (.36 versus .24). Collectively these data are quite supportive of curriculum upgrading efforts that require all students to take at least beginning level college preparatory coursework in mathematics. Even the A2M1 course, with its lower emphasis on algebra than for the general Algebra 1 sample, looks more like an Algebra 1 course than it looks like a prealgebra course. What these data don't show, of course, is the extent to which students are actually profiting from the algebra content covered.

The Math A course developed and implemented in California is also of special interest to this study. Math A is designed as a bridge course for students who are not yet ready to take Algebra 1. Rather than taking general math, often a dead end course, students take Math A, which is intended to offer worthwhile content in its own right while enhancing the possibility that students will take algebra and other advanced mathematics courses in the future. C2M2 is a Math A course in the target sample; its Dimension A data were presented in Table 5.1. In the original target sample, there was another instance of Math A, C1M1, for which only 82 days of log data were collected. While C1M1 was not included in the target sample analysis file because it did not meet the criterion of having the better part of a full school year of data, C1M1 does provide additional information for taking a closer look at Math A. Both Math A classes, C1M1 and C2M2, put greatest emphasis on algebra and geometry. The dual emphasis on algebra and geometry in Math A was unique among the target sample courses. In the case of C1M1, the proportions of instructional time are .38 algebra and .22 geometry, for a total of .60. In the case of C2M2, .48 time was spent on algebra and .34 time was spent on geometry, for a total of .82. The lesser emphasis on algebra and geometry in C1M1 was replaced by a greater emphasis upon arithmetic (.17) and measurement (.18). Within algebra, the Dimension B emphases were quite similar between the two courses. For each Math A course, greatest attention was given to expressions and linear equations: for C1M1 .14 expression and .11 linear equations and for C2M2 .13 expressions and .24 linear equations. Both courses also gave some emphasis to functions, .09 for C1M1 and .04 for C2M2. Subtopics of geometry were also similar for the two courses. The greatest emphasis was given to solid and coordinate geometry. For C1M1, measurement content emphasized measurement of area and volume primarily, and the arithmetic emphasized integers and relationships between numbers (order, magnitude).

There was one additional Math A course in the questionnaire sample, and it, too, put a dual emphasis on algebra and geometry, though it was similar to C1M1 in its emphasis on measurement as well.

Interestingly, both C1M1 and C2M2 indicated greater emphasis on statistics and probability in the questionnaire data than in the log data. The log data showed essentially no coverage of probability and statistics. It's difficult to know what to make of these discrepancies. In the case of C1M1, the log data are for the spring of a school year, while the questionnaire data are retrospective on the preceding fall. Perhaps probability and statistics are covered in the fall but not the spring. In the case of C2M2, the logs represent a full school year of data. The questionnaire data are for the fall of one year, while the fall log data are for the next year. Perhaps the content of the course shifted over time, deleting the emphasis on probability and statistics. Another plausible explanation is that both teachers believed probability and statistics should be included in their Math A instruction and completed the questionnaires accordingly. This explanation seems plausible, since the thirteen Math A units clearly include probability and statistics as a part of the intended curriculum. For whatever reason, however, probability and statistics did not actually get taught, at least as reflected in the daily logs.

Dimension C, mode of presentation. Dimension C characterizes content according to the way in which it is presented. The seven levels of Dimension C are exposition (verbal and written), pictorial models, concrete models (e.g., manipulatives), equations/formulas (e.g., symbolic), graphical, laboratory work, and field work. Instructional emphasis data for the levels of Dimension C are constructed in ways identical to the instructional emphasis data for Dimension A.

Table 5.5 presents Dimension C profiles for each of the 32 mathematics courses in the target sample. While the clear majority of courses have exposition as the dominant mode of presentation, Table 5.5 reflects considerable variance from course to course. S3M1, general mathematics, has an unusually high emphasis on lab work (.34). This South Carolina general math course provided remediation instruction for students having difficulty passing the tenth-grade BSAP mathematics test required for high school graduation. The lab work reported was for a drill-and-practice computer lab. Two Algebra 1 courses have especially high emphasis on presenting material through the use of concrete models, P2M2 (.46) and F3M2 (.41). Only one of the 32 courses used field work at all, and that course, C1M2 Algebra 1, used field work only 1 percent of the time. Similarly, lab work was nonexistent for the majority of the classes; with the one exception already noted, lab work never exceeded .04 of total instructional time. Perhaps not surprisingly, the three geometry courses used pictorial models as an emphasized mode of presentation, but the consumer math course, C2M1, used

Table 5.5

Content Variations Within and Between Course Titles: Math Dimension C

Course Location and Title	Exposit.	Pic. Models	Conc. Models	Equat./ Form.	Graph	Lab Work	Field Work
F1M1 Basic Skills	.86	.02	.02	.06	.03	.00	.00
F1M2 Gen Math	.97	.02	.00	.01	.01	.00	.00
F3M3 Gen Math 2	.71	.05	.00	.24	.00	.00	.00
S3M1 Gen Math	.52	.11	.02	.01	.00	.34	.00
M1M1 Gen Math	.24	.02	.00	.74	.00	.00	.00
C2M1 Consumer Math	.70	.27	.03	.00	.00	.01	.00
C3M2 Mastering Math	.82	.04	.04	.10	.00	.00	.00
M2M1 Practical Math	.90	.05	.02	.03	.00	.00	.00
A1M2 Prealg	.96	.01	.00	.02	.00	.00	.00
A3M1 Prealg	.39	.50	.02	.03	.02	.04	.00
C2M2 Math A	.56	.06	.26	.07	.02	.02	.00
F2M2 Prealg	.86	.00	.01	.08	.04	.01	.00
M3M1 Prealg	.57	.00	.00	.37	.06	.00	.00
A2M1 Alg 1[a]	.48	.03	.20	.21	.07	.00	.00
P1M1 Alg 1	.61	.01	.01	.33	.03	.00	.00
P1M2 Alg 1	.48	.01	.00	.43	.08	.00	.00
P2M1 Alg 1	.49	.04	.10	.31	.06	.00	.00
P2M2 Alg 1	.13	.05	.46	.35	.01	.00	.00

Table 5.5 Continued

Course Location and Title	Exposit.	Pic. Models	Conc. Models	Equat./ Form.	Graph	Lab Work	Field Work
P3M2 Alg 1[a]	.28	.00	.02	.62	.07	.01	.00
A1M1 Alg 1	.87	.00	.00	.13	.00	.00	.00
C1M2 Alg 1	.32	.12	.07	.31	.13	.02	.01
F3M2 Alg 1	.14	.01	.41	.33	.10	.00	.00
M2M2 Alg 1	.64	.04	.14	.14	.04	.00	.00
M3M2 Alg 1	.77	.00	.00	.14	.08	.00	.00
A2M2 Alg 2	.27	.07	.02	.56	.03	.04	.00
S1M1 Alg 2	.11	.01	.00	.83	.05	.00	.00
S2M1 Alg 2	.52	.06	.04	.29	.09	.00	.00
S3M2 Alg 2	.61	.05	.01	.31	.01	.01	.00
A3M2 Geo	.52	.28	.05	.11	.01	.03	.00
P3M1 Geo	.51	.35	.08	.02	.02	.01	.00
S2M2 Geo	.61	.22	.02	.08	.05	.01	.00
S1M2 Precalc	.57	.02	.00	.31	.11	.00	.00

[a] Required of all freshmen.

pictorial models .27 of its instructional time, and prealgebra course A3M1 used pictorial models .50 of its instructional time.

Table 5.6 presents means and standard deviations on Dimension C for each of the six course types: basic math, prealgebra, algebra 1, algebra 2, geometry, trig/precalculus. Clearly the heaviest emphasis on verbal and written exposition as a mode of instruction is in the lower level courses, basic math (.72, .240) and prealgebra (.67, .233). Algebra 1 and Algebra 2 courses are similar to each other in their average profiles on mode of presentation, but from Algebra 1 to Algebra 2, some of the emphasis on exposition gives way to emphasis upon equations. Trig/precalculus is similar to Algebra 1 and Algebra 2 but puts an even slightly higher emphasis on exposition and a greater emphasis on graphical presentations. Geometry makes the most heavy use of pictorial models, a pattern so clear it was easily seen in the course-by-course data.

These data on mode of presentation that reflect heavy emphasis on exposition and equations paint a fairly traditional picture of mathematics instruction. In contrast, the NCTM *Curriculum Standards* push for greater emphasis on models, especially concrete models and work with graphs. The NCTM *Standards*, with their emphasis on real world problems and data collection, also suggest much greater emphasis upon lab work and field work than was found in the log data.

Required courses and Math A as described on Dimension C. Of the two required Algebra 1 courses in the sample, A2M1 has a Dimension C profile virtually identical to that of the average Dimension C profile for Algebra 1 courses. A2M1 is the course noted earlier as putting a relatively lower emphasis upon algebra in comparison to other algebra classes in the sample. The other required Algebra 1 course, P3M2, put a lower emphasis upon exposition and on use of concrete models and almost twice as much emphasis upon equations and formulas as did the Algebra 1 sample. Apparently course P3M2 not only holds the line on content, as described by Dimension A, but it uses relatively fewer pedagogical strategies for promoting conceptual understanding than other Algebra 1

Table 5.6

Dimension C Means and Standard Deviations by Course Type for Math Courses

Course Type	*n*	Exposit.		Pic. Models		Conc. Models		Equat./ Form		Graph		Lab Work		Field Work	
		$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*
Basic Math	8	.72	.240	.07	.084	.02	.015	.15	.254	.00	.010	.04	.118	.00	.000
Prealgebra	5	.67	.233	.12	.216	.06	.114	.11	.143	.03	.024	.01	.015	.00	.000
Algebra 1	11	.47	.240	.03	.035	.13	.165	.30	.147	.06	.039	.00	.007	.00	.002
Algebra 2	4	.38	.229	.05	.030	.02	.015	.50	.254	.05	.035	.01	.020	.00	.000
Geometry	3	.55	.052	.28	.066	.05	.030	.07	.045	.03	.025	.02	.012	.00	.000
Trig/Precalc	1	.57	.000	.02	.000	.00	.000	.31	.000	.11	.000	.00	.000	.00	.000

courses.

The Math A course, C2M2, is distinctive among the sample of prealgebra courses in its emphasis on presenting material through concrete models (.26). Basically the increased use of concrete models is purchased by a decreased emphasis on presentation through exposition (.56 versus a prealgebra mean of .67). The same pattern holds for the Math A course not in the analysis file but for which 82 log days of information were available. For C1M1, the emphasis on concrete models (.14), though not as great as for C2M2, is twice as large as the prealgebra mean, while C1M1's emphasis on exposition was only .43. Further, C1M1 used pictorial models in an amount comparable to the prealgebra average while C2M2 may have accomplished its high emphasis on concrete models (.26) at a cost of lower emphasis on pictorial models (.06).

The Math A course is not unique within the sample, however, for its emphasis on concrete models. As already noted, two Algebra 1 courses used concrete models as the mode of presentation in excess of .40 of total instructional time. Nevertheless, the Math A course emphasis on concrete models is consistent with the intentions of that course as originally designed and is consistent with both the California math framework and the NCTM *Curriculum Standards*.

Dimension D, expected learner outcomes. Dimension D describes instruction in terms of the types of intended student academic outcomes. Dimension D describes what it is students are to know or to be able to do concerning the Dimension A and B topics. The nine levels of Dimension D are memorize facts/definitions/equations; understand concepts; collect data (e.g., observe, measure); order, compare, estimate, approximate; perform procedures: execute algorithms/routine procedures (including factoring), classify; solve routine problems, replicate experiments/replicate proofs; interpret data, recognize patterns; recognize, formulate, and solve novel problems/design experiments; build and revise theories/develop proofs.

Table 5.7 presents Dimension D profiles for each of the 32 courses in the math target sample. The data are constructed from daily logs, using the same procedures as for constructing data on Dimensions A, B, and C. Table 5.7 makes clear that there is enormous variation across courses for several levels of Dimension D: memorize facts, understand, routine procedures, and routine problems. The other levels of Dimension D have less variance primarily because they are rare in occurrence. Relatively little emphasis is given to collecting data, the one exception being the C2M2 Math A. Similarly, relatively little emphasis is given to interpreting data; surprisingly that holds for the C2M2 Math A course as well. Exceptions to the low emphasis on interpreting data are found among the Algebra 1 and Algebra 2 classes: Algebra 1 F3M2 (.09) and Algebra 2 A2M2 (.18) and S2M1 (.09). Solving novel problems receives virtually no attention in any of the more elementary level courses and 0 to 10 percent emphasis among the Algebra 1 and Algebra 2 courses. Theory and proof receives virtually no attention anywhere in the sample, not even in two of the three geometry courses; A3M2 geometry did put .05 emphasis on theory and proof.

Table 5.8 provides means and standard deviations on Dimension D by type of course. Basic math courses put heaviest emphasis upon understanding concepts (.46, .304), but collectively basic math courses also put considerable emphasis upon memorizing facts (.14, .141), routine procedures, meaning computation (.23, .294), and routine problems, meaning problems like the typical story problem (.14, .193). The profile for geometry courses is virtually identical on Dimension D to that for basic math courses (though the geometry standard deviations are much smaller). Prealgebra, Algebra 1, Algebra 2, and trig/precalculus courses all put major emphasis on computations (routine procedures), 50 percent or more of instructional time on computation for each of those four types of courses.

The levels of Dimension D that receive special emphasis in the NCTM *Curriculum Standards* are, in addition to understanding concepts, collecting data, interpreting data, and solving novel

Table 5.7

Content Variations Within and Between Course Titles: Math Dimension D

Course Location and Title	Mem. Facts	Under-stand	Col. Data	Order/ Est.	Routine Proced.	Routine Prob.	Inter. Data	Novel Prob.	Theory/ Proof
F1M1 Basic Skills	.16	.80	.00	.00	.04	.00	.00	.00	.00
F1M2 Gen Math	.00	.18	.00	.00	.26	.53	.03	.00	.00
F3M3 Gen Math 2	.10	.41	.01	.02	.13	.30	.02	.01	.00
S3M1 Gen Math	.22	.46	.04	.01	.03	.23	.00	.00	.00
M1M1 Gen Math	.20	.20	.00	.01	.57	.02	.00	.00	.00
C2M1 Consumer Math	.00	1.00	.00	.00	.00	.00	.00	.00	.00
C3M2 Mastering Math	.40	.50	.02	.05	.01	.02	.00	.00	.00
M2M1 Practical Math	.00	.15	.00	.02	.78	.05	.00	.00	.00
A1M2 Prealg	.05	.03	.00	.00	.89	.02	.00	.00	.00
A3M1 Prealg	.00	.08	.00	.01	.65	.23	.01	.01	.00
C2M2 Math A	.00	.60	.14	.01	.06	.13	.02	.04	.00
F2M2 Prealg	.04	.15	.01	.02	.58	.12	.01	.07	.00
M3M1 Prealg	.02	.13	.00	.01	.67	.14	.02	.02	.00
A2M1 Alg 1[a]	.14	.43	.02	.00	.25	.12	.03	.01	.00
P1M1 Alg 1	.01	.04	.00	.01	.68	.17	.02	.06	.00
P1M2 Alg 1	.01	.47	.01	.01	.47	.02	.00	.01	.00
P2M1 Alg 1	.21	.30	.04	.04	.29	.09	.02	.00	.00
P2M2 Alg 1	.01	.22	.00	.00	.52	.15	.04	.07	.00

Table 5.7 Continued

Course Location and Title	Mem. Facts	Under-stand	Col. Data	Order/ Est.	Routine Proced.	Routine Prob.	Inter. Data	Novel Prob.	Theory/ Proof
P3M2 Alg 1[a]	.00	.18	.10	.02	.23	.47	.00	.01	.00
A1M1 Alg 1	.02	.18	.00	.00	.79	.01	.00	.00	.00
C1M2 Alg 1	.01	.16	.01	.00	.45	.27	.05	.04	.01
F3M2 Alg 1	.10	.27	.01	.04	.26	.22	.09	.00	.00
M2M2 Alg 1	.05	.17	.00	.03	.62	.14	.00	.00	.00
M3M2 Alg 1	.03	.03	.00	.02	.48	.34	.04	.06	.00
A2M2 Alg 2	.01	.19	.00	.00	.32	.21	.18	.07	.00
S1M1 Alg 2	.00	.03	.00	.00	.84	.12	.00	.01	.00
S2M1 Alg 2	.24	.32	.01	.01	.20	.03	.09	.09	.01
S3M2 Alg 2	.08	.31	.00	.00	.53	.07	.00	.01	.00
A3M2 Geo	.14	.41	.01	.01	.15	.19	.02	.02	.05
P3M1 Geo	.09	.37	.02	.01	.33	.15	.00	.00	.00
S2M2 Geo	.29	.55	.01	.01	.01	.08	.02	.02	.02
S1M2 Precalc	.11	.14	.02	.00	.65	.07	.02	.00	.00

[a] Required of all freshmen.

Table 5.8

Dimension D Means and Standard Deviations by Course Type for Math Courses

Course Type	n	Mem. Facts		Under-stand		Col. Data		Order/ Est.		Routine Proced.		Routine Prob.		Inter. Data		Novel Prob.		Theory/ Proof	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
Basic Math	8	.14	.141	.46	.304	.01	.015	.01	.018	.23	.294	.14	.193	.01	.011	.00	.004	.00	.000
Prealgebra	5	.02	.022	.20	.231	.03	.060	.01	.007	.57	.305	.13	.074	.01	.008	.03	.029	.00	.000
Algebra 1	11	.05	.069	.22	.140	.02	.029	.01	.015	.46	.187	.18	.138	.03	.027	.02	.027	.00	.002
Algebra 2	4	.08	.108	.21	.138	.00	.004	.00	.006	.47	.279	.11	.081	.07	.086	.04	.039	.00	.007
Geometry	3	.17	.102	.44	.091	.01	.004	.01	.004	.17	.162	.14	.054	.01	.009	.01	.011	.02	.025
Trig/Precalc	1	.11	.000	.14	.000	.02	.000	.00	.000	.65	.000	.07	.000	.02	.000	.00	.000	.00	.000

problems. None of these three levels of Dimension D receive much attention in any of the types of courses studied. Algebra 2 courses place the heaviest emphasis on interpreting data and solving novel problems, .11 aggregated across the two categories. Algebra 1 courses are a distant second, with instructional time .05 across the two categories. As was already said, building and revising theories/developing proofs receives little to no attention anywhere in the sample of courses.

Table 5.9 presents means and standard deviations on Dimension D-like data from the questionnaire sample. In the interest of reducing response burden, the nine levels of Dimension D included in the log data were collapsed into four levels in the questionnaire: memorize facts/definitions/equations only; solve routine problems, replicate experiments; interpret data, solve novel problems, design experiments; and build and revise theory, develop proofs. Instructional emphasis for each of the four levels of questionnaire Dimension D were determined by calculating the ratio of the sum of AB topic weights for which the respondent indicated that the depth of coverage was best described by that particular level of Dimension D to the sum of all AB topic weights. For example, instructional emphasis for the memorize facts level of Dimension D was defined as the sum of weights for AB topics taught that were indicated as being taught with the intended student outcome being memorize facts divided by the sum of AB weights across all AB topics. In addition, a higher order thinking scale (HOT) was based on seven items in the questionnaire concerning the extent to which instruction was oriented toward indepth study, conceptual understanding, problem solving, and applications. Because each item in the HOT scale had a different response scale, the items were first put in standard score form (so that they were equally weighted), then summed, and the sum put in standard score form, with a total sample mean of 0 and standard deviation of 1.0.

Table 5.9 presents means and standard deviations for the four questionnaire Dimension D levels and the HOT scale. For each type of math course, there are some consistencies and some differences between the data in Table 5.9 and the data based on the teacher logs reported in Table

5.8. The amount of emphasis on memorizing facts is quite consistent between the two data sources, with slightly less emphasis being given to memorizing facts in basic courses for the questionnaire sample. Probably the lower emphasis upon memorizing facts in the questionnaire sample stems from a methodological difference from the log data. Questionnaire respondents were instructed to indicate "memorize facts" when that was the only level of Dimension D that served as an appropriate expected student outcome for a particular AB topic. Routine problems received by far the greatest emphasis for each course type; this result is also consistent with target sample data. The data in Table 5.9, however, indicated a much greater emphasis on "interpret data, solve novel problems, design experiments" and on "build and revise theory, develop proofs." To some extent, this is surely a function of the instructions to respondents. These categories were to be selected any time there was even the slightest attention given to those types of learner outcome. Nevertheless, the proportions of instructional time these categories received is so much greater than for the log data, desirable response bias is almost surely an important part of the explanation as well. The relative variation among courses on these two dimensions may be valid in the questionnaire sample, but the mean levels almost surely are not. The higher level courses, Algebra 1, Algebra 2, trig/precalculus, and calculus, place the greatest emphasis on solving novel problems. For theory/proof, not surprisingly, geometry, trig/precalculus, and calculus have the greatest emphasis.

The means on the HOT scale have only relative meaning since the scale was put in standard score form. The fact that all of the course types get negative mean values except for calculus reflects the fact that, in the total sample, science courses received the highest values for emphasis on higher order thinking and problem solving (HOT). Here and elsewhere there are at least two quite different possible interpretations of differences between math and science. One interpretation is that the differences reported by math and science teachers are representative of differences that would have been seen by an independent third party. The other interpretation is that math and science teachers

Table 5.9

Questionnaire Sample Expected Student Outcomes
Means and Standard Deviations by Course Type for Math Courses

Course Type	*n*	Mem. Facts		Routine Prob.		Novel Prob.		Theory/ Proof		HOT[a]	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
Basic Math	50	.07	.159	.66	.356	.17	.275	.10	.249	-.39	1.122
Prealgebra	13	.03	.052	.70	.341	.22	.296	.05	.128	-.15	1.049
Algebra 1	25	.02	.044	.61	.370	.28	.319	.09	.211	-.31	.759
Algebra 2	20	.01	.027	.62	.335	.32	.316	.04	.111	-.13	.952
Geometry	14	.06	.084	.48	.252	.19	.215	.27	.313	-.25	1.048
Trig/Precalc	12	.07	.228	.41	.319	.27	.306	.25	.349	-.13	.902
Calculus	6	.00	.000	.56	.310	.25	.231	.19	.284	.32	.571
Not Grouped	10	.01	.028	.62	.369	.13	.209	.24	.376	-.19	.922
Total	150	.04	.119	.61	.344	.23	.283	.13	.256	-.25	.980

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[a] HOT is a scale with grand mean zero and standard deviation equal to 1.0.

simply have different frames of reference and that their classroom practices are not as different as reported here. Looking across the several types of information, we are convinced that the first of these two interpretations is the more likely. Within the math sample, calculus courses stand out for their relatively heavy emphasis on higher order thinking and problem solving; the mean is one-third of a standard deviation above the mean for all math and science courses together and two-thirds of a standard deviation above the mean for basic math courses. The calculus courses also had the least amount of variance on the HOT scale (.571), while the other course types all had standard deviations similar to the standard deviation of the general sample. A surprising finding is the relatively low mean for geometry courses on the HOT scale (-.25).

Required courses and Math A as described in Dimension D. The two Algebra 1 courses in schools where all students were required to take Algebra 1 have profiles on Dimension D that contrast in interesting ways from the Algebra 1 average profile. Based on log data, both courses put a substantially lower emphasis on computation (routine procedures). The Algebra 1 mean was .46, with a standard deviation of .187, while the value for A2M1 was .25 and the value for P3M2 was .23. Course A2M1 made up for its lack of emphasis on computation by putting considerably more emphasis on memorization and understanding, a combined emphasis of .57 in comparison to the Algebra 1 courses combined mean of .27. These findings seem consistent with the earlier finding for Dimension A that course A2M1 put less emphasis on algebra and more emphasis on number and number relations and arithmetic. In contrast, course P3M2 put substantially more emphasis on "solve routine problems, replicate experiments/replicate proofs" than was true for the average of Algebra 1 courses (.47 versus .18). This finding is also consistent with earlier findings that course P3M2 seemed, if anything, to be more rigid and to have higher standards than other Algebra 1 courses.

The Math A course in the sample also differs from its referent group in important ways. In comparison to prealgebra courses, the Math A course, C2M2, placed three times as much emphasis on understanding concepts (.60 versus .20) and much less emphasis on computation (routine procedures), .06 for Math A versus .57 for prealgebra courses. Consistent with the Math A course design and intentions, C2M2 spent .14 of all instructional time on data collection in contrast to the mean of all prealgebra courses of only .03 time. The Math A course not in the target sample analysis file (because it had only 82 days of teacher logs) presents a somewhat similar picture with greater than average emphases on understanding (.31) and on collecting data (.08). Like C2M2, C1M1 also placed substantially less emphasis on computation/routine procedures (.02), but, unlike C2M2, it placed substantially more emphasis on solving routine problems and replicating proofs (.29). Encouragingly, the C1M1 Math A course also placed substantial emphasis on solving novel problems (.21 versus .03 for the prealgebra mean).

Science

Science topics: Dimensions A and B. The course-by-course profiles of instructional time across levels of Dimension A for the 30 science course sections for which log data are available are found in Table 5.10. The eight science levels of Dimension A are as follows: biology of the cell, human biology, biology of other organisms, biology of populations, chemistry, physics, earth and space science, and general science. Most of the rows in Table 5.10 have entries that sum to 1.0 or 100 percent of instructional time. Thus, as was found for mathematics, the science taxonomy Dimension A appears to capture virtually all of the content teachers taught. In no case did the proportion of instructional time captured by the Dimension A levels fall below .96; for slightly more than half the sample, Dimension A levels captured all of the reported content covered.

The 30 science courses described in Table 5.10 are listed roughly in order from most basic and introductory to more advanced. Courses of a type are grouped together. From these course-by-course instructional time profiles, several observations can be made.

Table 5.10

Content Variations Within and Between Course Titles: Science Dimension A

Course Location and Title	Bio. Cell	Bio. Human	Bio. Organism	Bio. Popu.	Chem.	Physics	Earth Sci.	Gen. Sci.
F2S1 General Science	.11	.08	.09	.14	.24	.24	.07	.05
S2S1 General Science	.02	.05	.00	.03	.22	.38	.11	.19
C3S1 Physical Science	.00	.00	.00	.01	.47	.38	.00	.14
F1S2 Physical Science	.00	.00	.00	.00	.40	.48	.01	.09
F3S1 Physical Science	.00	.00	.00	.00	.14	.57	.02	.26
M1S1 Physical Science	.00	.00	.00	.00	.32	.58	.00	.10
M3S1 Physical Science	.00	.00	.00	.01	.24	.58	.05	.08
S3S1 Physical Science	.00	.02	.01	.01	.32	.43	.03	.18
S1S1 C.P. Physical Science	.00	.00	.00	.00	.52	.32	.00	.16
A2S2 Freshman Chem/Physics[a]	.00	.00	.00	.00	.37	.37	.00	.24
F1S1 Fundamental Earth Science	.00	.00	.01	.16	.02	.04	.76	.02
M2S1 Earth Science	.00	.00	.00	.06	.06	.11	.58	.18
P3S1 Earth Science	.00	.00	.00	.00	.05	.02	.91	.02
C2S1 Life Science	.26	.34	.26	.00	.00	.00	.00	.14
C3S2 Life Science	.05	.19	.34	.33	.00	.00	.00	.09
A1S1 Biology	.23	.22	.21	.11	.11	.00	.00	.11
A2S1 Biology	.14	.29	.24	.22	.06	.00	.00	.04
F3S2 Biology	.18	.25	.40	.07	.01	.00	.00	.09

Table 5.10 Continued

Course Location and Title	Bio. Cell	Bio. Human	Bio. Organism	Bio. Popu.	Chem.	Physics	Earth Sci.	Gen. Sci.
M2S2 Biology	.12	.12	.11	.18	.08	.09	.13	.13
M3S2 Biology	.15	.01	.60	.12	.01	.01	.00	.11
P1S1 Biology	.26	.24	.48	.01	.00	.00	.01	.00
P1S2 Biology	.17	.04	.71	.04	.00	.00	.00	.00
P2S1 Biology	.18	.00	.56	.14	.03	.00	.00	.06
P2S2 Biology	.23	.08	.50	.00	.03	.03	.00	.12
P3S2 Biology	.18	.02	.60	.01	.13	.00	.00	.06
S3S2 Modern Biology	.24	.18	.21	.00	.07	.00	.00	.28
C1S1 Human Biology	.11	.38	.24	.11	.00	.01	.01	.12
A3S1 General Chemistry	.00	.00	.00	.00	.93	.00	.00	.07
S1S2 C.P. Chemistry	.00	.00	.00	.00	.88	.02	.00	.09
M1S2 Ecology	.00	.02	.04	.39	.08	.05	.06	.35

*Required of all freshmen.

Perhaps the most striking observation is the considerable amount of variability among courses labeled as biology. Several biology courses appear to be very much like introductory survey courses, spreading instructional time across four or more of the eight levels of Dimension A. A1S1 and A2S1 gave fairly equal emphasis to all four types of biology in the taxonomy (cell, human, other organisms, and populations) plus coverage of chemistry. Course C1S2, titled human biology, also spanned the four types of biology in Dimension A but did not include coverage of chemistry. Course M2S2 was an even broader survey course, extending the biology and chemistry coverage to include physics, earth and space science, and general science; M2S2 biology gave virtually even coverage to all eight levels of Dimension A.

Other biology courses were more focused. Several gave primary emphasis to biology of other organisms, but within that set there was considerable variation in coverage of other Dimension A levels. Some of these biology courses with a focus on biology of other organisms also gave considerable coverage to human biology and biology of the cell, others also gave considerable attention to biology of populations and biology of the cell, and still others were focused almost exclusively upon biology of other organisms and biology of the cell.

Most biology courses gave some attention to the topics covered under general science, but emphasis on general science varied widely. Topics under the label of general science are: nature and structure of science, nature of scientific inquiry, history of science, ethical issues in science, SI system of measurement, and science/technology in society. Given the potpourri of topics included under general science, it is not surprising that there would be considerable variability in its coverage. It is somewhat surprising, however, that there were any science courses that gave no coverage at all to any of the several general science topics. Two science courses in the sample gave no coverage to general science topics; both were biology courses, P1S1 and P1S2.

In contrast to the widely varying content makeup of biology courses, earth science and chemistry courses are much more sharply focused. Virtually all of the content reported as taught in the two chemistry courses was either chemistry or general science, and virtually all of the content reported as taught in the three earth science courses was earth science or general science.

Physical science classes were in all cases primarily a combination of chemistry, physics, and some general science content. For one of the physical science courses, however, chemistry received only .14 of instructional time, while general science topics received as much as .26.

General science courses look a good deal like physical science courses, the primary difference being that general science courses gave very modest attention to biology content, while physical science courses gave no attention to biology content at all.

Table 5.11 provides means and standard deviations by course type for the science target sample. The first two courses in Table 5.10 fall within the general science type. The next eight courses in Table 5.10 are labeled physical science in Table 5.11 and include college prep physical science as well as freshman chemistry and physics. The next three courses in Table 5.10 form the earth science type in Table 5.11, the next two life science, and the next 12 biology, including modern biology and human biology. The chemistry course type is made up of a general chemistry and a college prep chemistry course, and the ecology course type consists of the single ecology course in the sample.

From the analysis of science courses by type, several of the observations made from the course-by-course analysis in Table 5.10 are verified, some new patterns emerge, and, in the case of biology, some important variability among individual courses is disguised in the averages.

General science is clearly seen to be a broad survey course, giving some attention to all eight levels of Dimension A. Over half of general science can be described as chemistry and physics. Over 10 percent of the course is devoted to general science topics. All four types of biology are

Table 5.11

Dimension A Means and Standard Deviations by Course Type for Science Courses

Course Type	*n*	Bio. Cell		Bio. Human		Bio. Organism		Bio. Popu.		Chem.		Physics		Earth Sci.		Gen. Sci.	
		$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*
General Sci	2	.06	.065	.06	.023	.05	.063	.08	.077	.23	.013	.31	.102	.09	.035	.12	.104
Physical Sci	8	.00	.001	.00	.006	.00	.003	.00	.005	.35	.122	.46	.104	.01	.018	.15	.069
Earth Sci	3	.00	.002	.00	.002	.00	.003	.07	.080	.05	.025	.06	.051	.75	.168	.07	.093
Life Sci	2	.16	.148	.26	.110	.30	.058	.16	.230	.00	.003	.00	.000	.00	.000	.12	.032
Biology	12	.18	.048	.15	.125	.41	.195	.09	.074	.04	.046	.01	.026	.01	.038	.09	.074
Chemistry	2	.00	.002	.00	.000	.00	.000	.00	.000	.91	.031	.01	.014	.00	.002	.08	.018
Ecology	1	.00	.000	.02	.000	.04	.000	.39	.000	.08	.000	.05	.000	.06	.000	.35	.000
Total	30	.09	.097	.08	.117	.19	.230	.07	.101	.19	.246	.16	.211	.09	.230	.12	.084

given some but relatively little coverage, raising the question about whether general science coverage of biology might be cursory, with no real benefits for student learning.

Physical science is similar to general science in that chemistry and physics are the two most emphasized content areas. General science topics also receive considerable coverage in physical science courses. The difference between physical science and general science courses is that the physical science courses do not include a broad survey of biology and earth science content. In fact, physical science courses give essentially no coverage to any of the four types of biology distinguished by Dimension A of the taxonomy. Earth science receives no coverage in half of the physical science courses, and only 2 to 3 percent of total instructional time in the other half of the physical science courses.

Earth science is clearly focused on earth science content, with a mean instructional time for earth science of .75. The rather substantial standard deviation for earth science of .168 can be understood by looking at the three earth science courses as listed in Table 5.10. Still, for all three of these courses, earth science was by far the dominant content for the course. Earth science courses also devoted approximately 5 percent of instructional time to each of the content areas of chemistry, physics, and biology of populations.

Life science courses and biology courses look very much alike in terms of the means and standard deviations reported in Table 5.11. They are also alike in the sense of high course-to-course variability, as noted in Table 5.10. While the two life science courses, on average, look like biology courses, on average, those two life sciences courses were substantially different one from the other. Both life science courses devoted over 50 percent of instructional time to the combined content areas of human biology and biology of organisms, but they differed substantially in their coverage of biology of the cell and biology of populations. Thus, because of extreme variance for both life science courses and biology courses, the means and standard deviations in Table 5.11 disguise more than they reveal.

Chemistry courses are essentially chemistry. Over 90 percent of instructional time is devoted to chemistry content, and little variance occurred between the two courses (standard deviation of .031). Both chemistry courses also devoted some time to general science (.07 and .09).

The one ecology course in the sample gave almost equal attention to biology of populations (.39) and general science (.35). The remainder of the content in the course was spread across all but one of the remaining six levels of Dimension A; biology of the cell received no attention.

What Tables 5.10 and 5.11 also reveal is that, collectively across the 30 science course sections studied, significant attention is given to each of the eight groups of content represented by the eight levels of Dimension A. Contrary to the findings for mathematics, Dimension A science content all receives significant coverage at least somewhere in the collection of high school science course offerings. Of the eight levels of Dimension A, however, general science stands out as the one receiving most uniform coverage across all 30 course sections, with, as noted previously, only two biology course sections providing no coverage of general science. The other seven levels of Dimension A received essentially no coverage by one or more course types, with the exception of general science. As noted previously, general science is a survey course covering all Dimension A science content, at least to some modest degree.

For each course type, if a level of Dimension A received an average emphasis of .10 or more, a breakdown on Dimension B is provided. From Table 5.11, the following can be seen:

General science courses--chemistry (.23), physics (.31), general science (.12) = .66
Physical science courses--chemistry (.35), physics (.46), general science (.15) = .96
Earth science courses--earth science (.75)
Life science courses--biology of the cell (.16), human biology (.26), biology of other organisms (.30), biology of populations (.16), general science (.12) = 1.00

Biology courses–biology of the cell (.18), human biology (.15), biology of other organisms (.41) = .74

Chemistry courses–chemistry (.91)

Ecology course–biology of populations (.39), general science (.35) = .74

From the above, it can be seen that science courses are less focused than were math courses; more levels of Dimension A are needed to capture the content of science courses than was the case for mathematics. When attempting to describe a course by only those levels of Dimension A for which instructional emphasis exceeded .10, not only was a smaller fraction of total instructional time accounted for in science than in mathematics, but, in the case of life science courses, it was necessary to include five of the eight levels of Dimension A in the course description.

Dimension B of the science content taxonomy breaks down each level of Dimension A into from six to ten subtopics each. Dimension B, then, provides the opportunity for describing course content in greater detail than was done in Tables 5.10 and 5.11.

In describing the sample of science target courses on Dimension B, general science as a Dimension A category of content is a good place to start. Virtually all 30 science course sections gave at least some attention to topics included under general science. Therefore, Dimension B means across all 30 courses for general science content are of interest. The general science topic receiving most emphasis in the 30-course sample was the nature of scientific inquiry, with a mean of .042. The next most emphasized Dimension B topic was the nature and structure of science (.027), followed by the SI system of measurement (.025) and science/technology in society (.017). The topics history of science and ethical issues in science received, on average, less than .01 of total instructional time.

Of the course types, ecology, with only a single course, gave the most emphasis to general science (.35). Within that course, it was science/technology in society that received the most emphasis (.126). Also receiving considerable attention were the topics of nature and structure of science (.073), nature of scientific inquiry (.069), and the SI system of measurement (.069).

Physical science, general science, and life science course types also, on average, gave more than 10 percent of instructional time to general science content. For general science, the most emphasized Dimension B topic was the SI system of measurement (.03, .044). For physical science, the most emphasized Dimension B topic was the nature of scientific inquiry (.06, .069) , and for life sciences the most emphasized Dimension B topic was the nature and structure of science (.06, .014). In the case of physical science, the SI system of measurement also received considerable attention (.05, .027). For general science, physical science, and life science course types, all six levels of Dimension B under general science topics received at least 2 to 3 percent of instructional emphasis, with the exception of the two topics history of science and ethical issues in science, which received essentially no attention.

For biology, chemistry, and earth science course types, the most emphasized general science Dimension B topic was the nature of scientific inquiry, receiving approximately 3 percent of instructional time in each case. Chemistry and earth science also gave approximately .02 emphasis to the SI system of measurement; the SI system of measurement received essentially no coverage in biology.

General science, physical science, and chemistry courses all gave considerable emphasis to chemistry topics. Table 5.12 presents a comparison of these three courses on levels of Dimension B for chemistry. The general science and physical science courses were similar to each other in giving some small emphasis to each of the following topics: periodic system, bonding, energy relationships, and equilibrium in chemical systems, with instructional coverage varying from .01 to .03. Physical science courses gave considerably more emphasis to chemical properties and processes (.07, .058) than did general science courses (.02, .026). In contrast, general science courses gave more attention to environmental chemistry (.03, .042) than did physical science courses (.00, .011). Both courses

Table 5.12

Comparison of Chemistry Content in General Science, Physical Science, and Chemistry Courses

Course Type	Periodic System		Bonding		Properties and Processes		Atomic Molecular Structure		Energy Relations		Reactions		Equilibrium		Organic		Nuclear		Environmental	
	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
General Science	.03	.025	.03	.018	.02	.026	.05	.052	.01	.002	.03	.036	.01	.008	.00	.004	.00	.000	.03	.042
Physical Science	.03	.024	.03	.022	.07	.058	.07	.045	.01	.016	.10	.051	.00	.007	.02	.035	.01	.021	.00	.011
Chemistry	.06	.038	.02	.018	.24	.074	.21	.209	.09	.044	.06	.036	.03	.033	.05	.067	.07	.096	.07	.084

gave relatively more attention to atomic and molecular structure, with physical science courses giving slightly more (.07, .045) than general science courses (.05, .052). Neither general science nor physical science courses spent time on the topics of organic chemistry, nuclear chemistry, or equilibrium.

Chemistry courses, with their almost exclusive focus on chemistry content, gave much more attention to most of the Dimension B topics for chemistry content than did either general science or physical science courses. Nevertheless, the profile of relative content emphases for chemistry courses across levels of Dimension B on chemistry was somewhat similar to physical science and general science courses. The two most emphasized chemistry topics in the two chemistry courses studied were chemical properties and processes (.24, .074) and atomic and molecular structure (.21, .209). The remaining eight topics in Dimension B for chemistry all received some attention in the chemistry courses studied; instructional emphases ranged from .02 instructional time for bonding to .09 for energy relationships and equilibrium in chemical systems.

Both physical science and general science courses also emphasized physics as a content area of instruction. For both course types, the most emphasized Dimension B subtopic of physics was energy: sources and conservation, with means and standard deviations of (.15, .035) for general science courses and (.11, .046) for physical science courses. General science courses also gave at least some attention to all eight of the other physics Dimension B subtopics: heat (content and transfer), static and current electricity, magnetism and electromagnetism, sound, light and spectra, machines and mechanics, properties and structures of matter, molecular and nuclear physics. Instructional emphases ranged from .01 to .03. In contrast, physical science courses gave virtually no attention to molecular and nuclear physics but gave considerable attention to the topics of properties and structures of matter (.08, .061), machines and mechanics (.07, .055), and static and current electricity (.06, .085). Physical science courses were similar to general science courses in giving modest amounts of instructional time to the remaining Dimension B physics subtopics.

As has been noted, the three earth science courses devoted over 75 percent of their instructional time to earth science content. Looking within the earth science content area, the single most emphasized topic for earth science courses was geology (.25, .179), with the solar system (.16, .046) a not-too-distant second. All remaining six levels of Dimension B earth and space science received at least some attention, and meteorology (.10, .163) and the earth's history (.09, .143) received considerable emphasis.

The pictures for life science and biology courses are somewhat more complicated. Within their emphasis on biology of cell content, life science courses limited their coverage to only two of the seven Dimension B levels, cell structure (.07, .052) and cell function (.07, .088). In contrast, biology courses spread instructional time across all seven of the biology of the cell Dimension B subtopics; for each subtopic instructional time was less than 5 percent. Similarly, for human biology content, the life science courses were much more focused on a few subtopics than were the biology courses. Life science courses gave most attention to skeletal and muscular system (.11, .074), but approximately 5 percent of instructional time was also given to circulatory system (.04, .027) and reproduction (.06, .042). Again, the biology courses spread instructional time across all ten levels of human biology Dimension B, with no one of those subtopics receiving as much as 3 percent of instructional time.

For the content area of biology of other organisms, life science courses and biology courses were much more similar. The single most emphasized topic was diversity of life, with, for both of the two course types, an average instructional emphasis of approximately .12 and a standard deviation of approximately .110. Other Dimension B biology of other organisms subtopics receiving attention were reproduction and development of plants, reproduction and development of animals, and heredity. Content emphases for these subtopics across these two course types ranged from 3 percent to 13 percent. In addition to topics already mentioned, life science courses gave some attention to coordination and behavior of the organism (.03, .037). The subtopics of metabolism of the organism, regulation of the organism, and biotechnology received virtually no instructional emphasis in either life science courses or biology courses.

In addition to general science, the most emphasized content area for the ecology course was biology of populations. Biology of populations also received considerable emphasis in the two life science courses. The ecology course gave some attention to all but two of the nine Dimension B levels of biology of populations. Virtually no attention was given to population genetics, nor to evolution. Considerable attention was given to natural environment; cycles in nature; producers, consumers, decomposers; natural groups and their segregation; adaptation and variation in plants; adaptation and variation in animals; and ecology. In contrast, life science course coverage of biology of populations was much more focused. By far the greatest emphasis was given to ecology (.11, .160), but 2 to 3 percent instructional time was also given to natural groups and their segregation and to evolution (a topic given essentially no attention in the ecology course).

From these Dimension A and Dimension B descriptions of the target science courses, a general picture of breadth of coverage emerges. Across the 30-course sample, all of the Dimension A content areas received considerable coverage by at least one of the several course types studied. Further, when looking within Dimension A content areas to coverage of more specific subtopics, most of the Dimension B subtopics identified in the taxonomy received some attention by at least one course type. In contrast, the sample of mathematics courses was much more focused, both at the Dimension A level of description and, within the levels of Dimension A, at the Dimension B level of description.

The Questionnaire Sample. Table 5.13 presents content coverage means and standard deviations on Dimension A by course type based on the science questionnaire sample. Of the 144 science teachers who completed the questionnaire, 130 (90 percent) had usable questionnaire data for Item 85 that asked teachers to describe their instruction in terms of Dimension A and B topics.

When interpreting the data in Table 5.13, and comparing those data to the log sample data in Table 5.11, several differences between the log data set and the questionnaire data set must be kept in mind. First, questionnaire data describe content for only the first half of the school year, while logs describe instruction across both semesters of a school year. Second, questionnaire data come from reporting at a single point in time. For part of the sample, the data are retrospective accounts of content covered during the fall of a year for which logs were not collected, and for the remainder of the sample, questionnaire data are prospective data for the fall semester for which logs were collected. In contrast, logs are daily accounts of content taught. Third, the scale for reporting content emphases used in the questionnaire was limited to four levels (not taught, taught less than 2 hours, taught 2 to 10 hours, taught more than 10 hours). In comparison to the log data, then, questionnaire data overweight topics taught only briefly, perhaps only for exposure, and underweight topics taught for considerable periods of time. With these methodological differences between the two data sets in mind, comparisons of data in Table 5.13 to data in Table 5.11 are suggestive about the representativeness of the log sample. In addition, Table 5.13 includes a description of 14 physics courses; physics was not a course type available in the log sample.

Similar to the log data, questionnaire data reveal that most course types gave considerable emphasis to general science content topics; earth science courses were the sole exception. For five of the seven course types for which log data were available, questionnaire sample data reflected a greater fraction of total instructional time on general science than did log data. The biggest difference was, perhaps not surprisingly, for general science courses where the mean instructional time went from .12

488

Table 5.13

Questionnaire Sample Means and Standard Deviations
by Course Type for Science Courses

Course Type	n	Bio. Cell		Bio. Human		Bio. Organism		Bio. Popu.		Chem.		Physics		Earth Science		Gen. Sci.	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
General Sci	15	.04	.085	.05	.101	.05	.073	.05	.074	.12	.168	.15	.184	.08	.113	.47	.379
Physical Sci	21	.00	.000	.00	.006	.00	.000	.00	.009	.37	.260	.37	.251	.02	.057	.23	.179
Earth Sci	5	.05	.112	.00	.000	.00	.000	.05	.083	.10	.224	.08	.103	.70	.406	.02	.045
Life Sci	6	.20	.110	.17	.262	.11	.086	.20	.165	.09	.089	.02	.019	.02	.036	.21	.078
Biology	33	.24	.141	.14	.139	.16	.092	.17	.128	.13	.131	.01	.016	.02	.037	.13	.099
Chemistry	13	.01	.024	.00	.004	.00	.012	.00	.008	.78	.208	.03	.078	.01	.020	.17	.155
Physics	14	.01	.043	.01	.043	.01	.034	.00	.013	.07	.188	.68	.276	.01	.028	.20	.216
Ecology	5	.05	.038	.06	.068	.09	.051	.46	.325	.06	.074	.07	.050	.09	.054	.11	.081
Not Grouped	18	.15	.160	.14	.188	.14	.141	.12	.173	.13	.172	.06	.095	.09	.245	.18	.164
Total	130	.10	.142	.07	.133	.07	.101	.10	.155	.22	.275	.17	.266	.06	.182	.20	.213

for log data to .47 for questionnaire data. The questionnaire data standard deviation for general science courses on general science content was a very large .379. Only for earth science courses and ecology courses were the general science means for questionnaire data lower than the general science means for log data. Neither of these differences seems important, however, since the earth science course difference was small, and the log sample data included only a single ecology course.

At least a portion of the tendency toward greater emphasis on general science in the questionnaire sample can be attributed to methodological differences between the two samples. General science topics tend to each receive a relatively small investment of instructional time; as was noted, questionnaire data overweight such topics. Nevertheless, almost certainly the large difference for general science courses in coverage of general science content reflects an underestimate in the log data. The single ecology course in the log sample obviously overestimated for ecology courses their typical emphasis on general science content.

For general science courses, the increase in emphasis of general science topics in the questionnaire sample was offset by relatively less emphasis on chemistry and physics content. For the log sample, over 50 percent of general science course content was on chemistry and physics topics. In the questionnaire sample, only 37 percent of general science course instructional time was devoted to chemistry and physics topics.

Physical science courses looked much the same from the questionnaire data as they did from the log data. Chemistry and physics were still the two most emphasized content areas, each with an instructional time mean of .37 (and standard deviations of .260 for chemistry and .251 for physics). General science content is also emphasized in physical science courses in the questionnaire sample (.23, .179).

Questionnaire earth science courses are dominated by earth science content, just as they were in the log sample, but the standard deviation was very large (.70, .406).

In the questionnaire sample, life science courses are dominated by biology content, much as they were in the log sample, although in the questionnaire sample lower emphases on human biology and biology of other organisms was made up for by increased emphases on chemistry and general science content. From the questionnaire data, life science courses look like broad survey courses, covering all of the Dimension A content areas except for physics and earth science. On average, questionnaire sample biology courses looked much like questionnaire sample life science courses. Comparisons between the two course types on questionnaire data reveal only modest differences for each level of Dimension A, in terms of both means and standard deviations of instructional time.

Questionnaire chemistry courses focus on chemistry content (.78, .208) and general science (.17, .155). The questionnaire sample picture for chemistry is much like the log sample picture for chemistry, with slightly less exclusive emphasis on chemistry compensated for by slightly more attention given to general science content. Similarly, questionnaire sample physics courses are dominated by physics content (.68, .276), and, to a lesser extent, general science (.20, .216).

The content of ecology courses is best described as half biology of populations (.46, .325), with the other half divided fairly evenly across the other seven levels of Dimension A. This picture is quite consistent with the log data, except that in the log data more emphasis was given to general science content and less to the several other levels of Dimension A.

Required Science Course as Described by Dimensions A and B. Of the 30 science target courses, only one was in a school where the course was required of all students. Freshman chemistry/physics was a required course of study for all students in one of the two Arizona urban high schools (target course A2S2). The most similar course type, and in fact the course type in which the required freshman chemistry/physics course was included in Table 5.11, is physical science. Within that sample of physical science courses is also a college prep physical science course to which the required chemistry/physics course can be compared.

As can be seen from Table 5.10, freshman chemistry/physics science in the Arizona high school gave equal coverage to chemistry and physics content (.37 for each content area) and slightly less coverage to general science (.24). The five other levels of Dimension A received no content coverage at all in the course. This profile is very similar to the college prep physical science course offered in one of the two South Carolina urban high schools (S1S1). In the CP physical science course, somewhat less emphasis was given to general science (.16) and somewhat more emphasis was given to chemistry (.52). As seen in Table 5.11, A2S2 fell within one standard deviation of the mean for all physical science courses in the log sample on seven of the eight levels of Dimension A. The only exception was for general science content, which was more emphasized in A2S2.

When looking within the Dimension A content areas to subtopics defined by Dimension B, several additional features of the required chemistry/physics course are revealed. In contrast to both the South Carolina college prep physical science course and the average of all physical science courses, the required chemistry/physics course placed a much greater emphasis in chemistry on atomic and molecular structure (.14) and energy (.05) (Table 5.14). Both of these differences are about two standard deviations more than either the college prep physical science course or the mean of all physical science courses. In contrast, the required chemistry/physics course gave less coverage to chemical properties and processes (.02), organic chemistry (.00), and nuclear chemistry (.00).

For physics content, there were more similarities than differences on Dimension B subtopics between the required chemistry/physics course, the college prep physical science course, and the average of all physical science courses (Table 5.15). The required chemistry/physics course placed more emphasis on properties and structures of matter (.17) in comparison to physical science courses (.08, .061). The required chemistry/physics course gave no attention to the topics of static and current electricity and magnetism, and neither did the college prep physical science course. On

Table 5.14

Freshman Chemistry/Physics Course Required of All Students:
Chemistry Dimension B Comparisons

Course		Total	Periodic System	Bonding	Properties & Processes	Atomic & Molecular Structure	Energy	Relations	Equilibrium	Organic	Nuclear	Environmental
Chem/Physics (A2S2)		.37	.05	.02	.02	.14	.05	.09	.00	.00	.00	.00
College Prep Physical Science (S1S1)		.52	.06	.01	.14	.05	.01	.11	.00	.08	.06	.00
Physical Science Courses	$\bar{X}$	.35	.03	.03	.07	.07	.01	.10	.00	.02	.01	.00
	s	.122	.024	.022	.058	.045	.016	.051	.001	.035	.021	.011

Table 5.15

Freshman Chemistry/Physics Course Required of All Students: Physics Dimension B Comparisons

Course		Total	Energy: Sources & Conservation	Heat	Static & Current Electricity	Magnetism	Sound	Light & Spectra	Machines & Mechanics	Properties & Structures of Matter	Molecular & Nuclear Physics
Chem/Physics (A2S2)		.37	.09	.00	.00	.00	.04	.01	.06	.17	.00
College Prep Physical Science (S1S1)		.32	.14	.03	.00	.00	.07	.00	.03	.04	.00
Physical Science Courses	$\bar{X}$	.46	.11	.03	.06	.04	.04	.03	.07	.08	.00
	s	.104	.046	.023	.085	.069	.024	.040	.055	.061	.002

average across all physical science courses, however, these topics received modest coverage (static and current electricity, .06, .085; magnetism, .04, .069).

Within general science content, the greater amount of emphasis on general science found for the required chemistry/physics course was divided fairly equally between the two topics, nature and structure of science and nature of scientific inquiry (Table 5.16). For nature and structure of science, instructional emphasis was .10, much greater than in the college prep physical science course (.03) and the sample of physical science courses (.02, .034). For the nature of scientific inquiry, coverage was also .10, which compares to .05 for the college prep physical science course (.06) and for all physical science courses.

In sum, then, there are some differences among the required freshman chemistry/physics course, the college prep physical science course and the average of all physical science courses, but none of the differences seems particularly remarkable. Nothing from Dimensions A and B suggests that the course is either easier or more challenging than other physical science courses.

Dimension C. Mode of Presentation. Table 5.17 presents Dimension C profiles for each of the 30 science courses in the target sample. The seven levels of Dimension C are exposition-verbal and written, pictorial models, concrete models, equations/formulas, graphical, laboratory work, and field work.

The first feature noted in Table 5.17 is the heavy reliance on verbal and written exposition as the mode of instruction in science courses. In one general science course (F2S1), 95 percent of instructional time involved written or verbal exposition. The least emphasis on written and verbal exposition was 39 percent for a life science course (C2S1). Exposition was the single most frequent mode of instructional presentation for every science course studied.

Table 5.16
Freshman Chemistry/Physics Courses Required of All Students:
General Science Dimension B Comparisons

Course	Total	Nature & Structure	Scientific Inquiry	History	Ethical	SI System	Science/ Technology
Chem/Physics (A2S2)	.24	.10	.10	.00	.00	.04	.00
College Prep Physical Science (S1S1)	.16	.03	.05	.02	.00	.04	.01
Physical Science Courses $\bar{X}$	.15	.02	.06	.00	.00	.05	.02
s	.069	.034	.069	.008	.002	.027	.014

Table 5.17

Content Variations Within and Between Course Titles: Science Dimension C

Course Location and Title	Exposit.	Pic. Models	Conc. Models	Equat./ Form.	Graph	Lab Work	Field Work
F2S1 General Science	.95	.02	.00	.00	.00	.03	.00
S2S1 General Science	.59	.29	.03	.01	.02	.05	.00
C3S1 Physical Science	.51	.12	.02	.13	.01	.21	.00
F1S2 Physical Science	.63	.07	.04	.04	.01	.21	.00
F3S1 Physical Science	.48	.09	.04	.14	.02	.21	.01
M1S1 Physical Science	.53	.26	.04	.07	.04	.03	.01
M3S1 Physical Science	.94	.02	.00	.01	.00	.03	.00
S3S1 Physical Science	.41	.21	.03	.22	.05	.07	.00
S1S1 C.P. Physical Science	.74	.04	.04	.06	.01	.11	.00
A2S2 Freshman Chem/Physics	.48	.15	.13	.16	.04	.04	.00
F1S1 Fundamental Earth Science	.86	.14	.00	.00	.00	.00	.00
M2S1 Earth Science	.59	.22	.06	.06	.02	.04	.01
P3S1 Earth Science	.75	.09	.04	.01	.02	.09	.00
C2S1 Life Science	.39	.25	.24	.01	.00	.12	.01
C3S2 Life Science	.65	.09	.02	.00	.00	.24	.00
A1S1 Biology	.51	.12	.03	.01	.01	.23	.08
A2S1 Biology	.92	.04	.00	.00	.00	.04	.00
F3S2 Biology	.78	.11	.01	.02	.00	.07	.01

Table 5.17 Continued

Course Location and Title	Exposit.	Pic. Models	Conc. Models	Equat./ Form.	Graph	Lab Work	Field Work
M2S2 Biology	.56	.27	.09	.03	.01	.04	.00
M3S2 Biology	.75	.02	.04	.03	.00	.15	.00
P1S1 Biology	.55	.28	.06	.01	.00	.01	.00
P1S2 Biology	.79	.16	.01	.00	.00	.04	.00
P2S1 Biology	.75	.14	.02	.01	.02	.05	.00
P2S2 Biology	.63	.22	.06	.01	.01	.07	.00
P3S2 Biology	.67	.18	.05	.01	.00	.08	.00
S3S2 Modern Biology	.53	.18	.15	.02	.00	.09	.01
C1S2 Human Biology	.74	.21	.00	.00	.00	.05	.00
A3S1 General Chemistry	.51	.09	.04	.17	.03	.16	.00
S1S2 C.P. Chemistry	.57	.11	.06	.13	.01	.11	.02
M1S2 Ecology	.54	.18	.09	.01	.10	.07	.00

The next most striking pattern is that, with the exception of one biology course (A1S1), science courses make little to no use of field work. The pattern for graphical work, though not quite so stark, is similar to that for field work. An exception was the ecology course (M1S2), where 10 percent of instructional time was spent with graphs as the mode of instruction. In two-thirds of the courses, however, graphs as a mode of instructional presentation represented one percent or less of total instructional time.

The amount of lab work was quite variable, with no clear pattern in the data. Seven courses in the log sample allocate 15 percent to 24 percent of instructional time for lab work, but this set of seven courses spanned the course types of physical science, life science, biology, and chemistry. In contrast, nearly half of the 30 science courses allocated 5 percent or less of instructional time for lab work.

Equations and formulas were common to chemistry courses (.13 and .17) and to four of the eight physical science courses (from .13 to .22); the four physical science courses using equations and formulas were the same four that gave a relatively greater emphasis to general science. In the other science courses, equations and formulas constituted from 0 to 3 percent of instructional time.

Pictorial models were a fairly common mode of instruction, with nearly half of the sample of courses using pictorial models as the mode of instruction for 15 percent or more of instructional time. In contrast, only two courses used concrete models as the mode of instruction 15 percent or more of the time. In neither case was there a clear relationship between amount of use of concrete and/or pictorial models and course type.

Table 5.18 presents means and standard deviations on Dimension C for each of the seven science course types. While there was considerable variability from course to course in the relative use of verbal and written exposition, as seen in Table 5.17, no clear relationship emerges by course type in Table 5.18. Perhaps chemistry courses are a bit less reliant on verbal and written exposition

Table 5.18

Dimension C Means and Standard Deviations
by Course Type for Science Courses

Course Type	*n*	Exposit.		Pic. Models		Conc. Models		Equat./ Form.		Graph		Lab Work		Field Work	
		$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*
General Sci	2	.77	.253	.16	.190	.01	.020	.01	.007	.01	.017	.04	.016	.00	.000
Physical Sci	8	.59	.172	.12	.083	.04	.037	.10	.070	.02	.017	.12	.082	.00	.005
Earth Sci	3	.73	.135	.15	.066	.03	.031	.02	.034	.01	.009	.04	.046	.00	.004
Life Sci	2	.52	.183	.17	.107	.13	.154	.00	.004	.00	.000	.18	.088	.00	.005
Biology	12	.68	.127	.16	.081	.04	.043	.01	.010	.00	.001	.08	.056	.01	.022
Chemistry	2	.54	.037	.10	.014	.05	.010	.15	.024	.02	.017	.13	.035	.01	.014
Ecology	1	.54	.000	.18	.000	.09	.000	.01	.000	.10	.000	.07	.000	.00	.000

than are the other science course types, with a mean of .54 and a very small standard deviation of .037. The chemistry sample is small, however, consisting of only two courses.

Neither is there a clear pattern by course type for use of pictorial models. On average, pictorial models constituted approximately 15 percent of instructional time for each course type with the possible exception, again, of chemistry, with a mean of .10 and a very small standard deviation of .014. The two life science courses appear to make the greatest use of concrete models (.13, .154), but that is really misleading. One life science course used concrete models 24 percent of the time, while the other used concrete models only 2 percent.

Equations and formulas appear to be a significant part of instruction for only physical science and chemistry courses. Graphs are emphasized only in the ecology course, although with only one ecology course in the sample, it is difficult to judge whether 10 percent is representative. Since no questionnaire data are available on Dimension C, checking the generalizability of this use of graphs with the larger sample of five ecology courses is not possible.

Analysis of lab work by course type in Table 5.18 may obscure as much as it reveals. As seen in Table 5.17, the degree to which lab work was a part of instruction was very much specific to a particular course offering. As already noted, field work was essentially not a part of instruction except in one biology class.

Required Courses as Described on Dimension C. The freshman chemistry/physics course required of all students in the Arizona urban high school, A2S2, has a profile on Dimension C that is somewhat distinct from other physical science courses in the sample. A2S2 has a relatively lower emphasis on verbal and written exposition (.48) and a relatively higher emphasis on use of concrete models. Between pictorial models and concrete models, 28 percent of instructional time is accounted for, more than all but two of the other courses in the 30-course log sample of science courses. This relative deemphasis on exposition and heavier emphasis on models seems pedagogically appropriate for a course that is attempting to reach all students, regardless of their past achievements or future educational aspirations.

There is no reason to interpret Dimension C data as evidence of an attempt to water down the course. A2S2 gave more emphasis to equations and formulas (.16) than did physical science courses in the sample on average (.10, .070) and considerably more than did the South Carolina urban school college prep physical science course (.06). The required course also included some graph work (.04) and some lab work (.04). Like all but one of the other courses in the sample, however, the course allocated no time for field work.

In addition to the required chemistry/physics course, the data provide another special opportunity for looking at the effects on instruction of external standard setting. In South Carolina, at least 20 percent of instructional time is to be used for lab work if a science course is to count toward graduation. Also in that state, the public universities require two years of lab science for admission. In Florida, the lab requirement is even stiffer. Forty percent of instructional time in science courses is to be lab work. To encourage lab work in science courses, the state offers monetary incentives to schools that meet the 40 percent requirement. Also in Florida, public universities require two years of lab science for admission. In neither state is there any rigorous monitoring of lab requirements. In Florida, schools that receive the state incentive money must complete a form stating that 40 percent time was allocated to lab work in their science courses, but the validity of these forms is never checked. In South Carolina, there is no monitoring of the standard at all.

The log sample includes five science courses from Florida and five science courses from South Carolina. These can be used to see the extent to which state requirements for lab time were met. The Florida sample of science courses includes general science (F2S1), with lab time of .03; two physical science courses (F1S2, F3S1), each with lab time .21; fundamental earth science (F1S1), with no lab time; and biology (F3S2), with .07 lab time. While two of these five Florida science courses meet the South Carolina requirement, none of them comes close to meeting the Florida requirement. Further, only two give any significant emphasis to lab work. For the South Carolina sample of courses, practice is equally discrepant from state requirements: a general science course (S2S1) with .05 lab time; a physical science course (S3S1) with .07 lab time; a modern biology course (S3S2) with .09 lab time; the college prep physical science course with .11 lab time; and a college prep chemistry course with only .11 lab time.

Clearly, state requirements for lab time in science courses are not sufficient to ensure lab time occurs, at least not as implemented in Florida and South Carolina. Even monetary inducements with schools certifying that they met the requirements is not sufficient. Schools in Florida were completing forms saying they met the lab requirement and receiving state money as a result, but clearly the science teachers in our log sample were not meeting the requirement.

As an aside, the fact that Florida and South Carolina teachers reported amounts of lab work in their science courses that documented they were out of compliance with state requirements reflects positively on the overall validity of our self-report daily log data. Clearly, these teachers did not distort the data to make their classes look good.

Dimension D Expected Learner Outcomes. Table 5.19 presents Dimension D profiles for each of the 30 courses in the science target sample. There is great variability from course to course, especially for the first two levels of Dimension D, memorize facts/definitions/equations and understand concepts. Together, these two levels of Dimension D account for from 50 percent to nearly 100 percent of instructional time. In fact, for nearly one-third of the courses, 90 percent or more of instructional time was devoted to memorizing facts and understanding concepts. At the other extreme are the last two levels of Dimension D. There is virtually no variance among courses on recognize, formulate, and solve novel problems/design experiments and build and revise

Table 5.19

Content Variations Within and Between Course Titles: Science Dimension D

Course Location and Title	Mem. Facts	Under-stand	Col. Data	Order/ Est.	Routine Proced.	Routine Prob.	Inter. Data	Novel Prob.	Theory/ Proof
F2S1 General Science	.04	.93	.03	.00	.00	.00	.00	.00	.00
S2S1 General Science	.23	.56	.02	.10	.01	.03	.04	.00	.00
C3S1 Physical Science	.02	.56	.13	.01	.09	.10	.05	.03	.01
F1S2 Physical Science	.15	.52	.16	.11	.00	.04	.01	.00	.00
F3S1 Physical Science	.06	.39	.08	.05	.02	.11	.22	.04	.04
M1S1 Physical Science	.56	.34	.02	.02	.00	.04	.01	.02	.01
M3S1 Physical Science	.66	.28	.02	.00	.00	.02	.01	.01	.00
S3S1 Physical Science	.26	.29	.09	.06	.06	.15	.05	.03	.00
S1S1 C.P. Physical Science	.59	.21	.08	.02	.02	.03	.03	.02	.00
A2S2 Freshman Chem/Physics	.20	.37	.08	.05	.06	.14	.07	.02	.00
F1S1 Fundamental Earth Science	.26	.72	.02	.00	.00	.00	.00	.00	.00
M2S1 Earth Science	.21	.33	.08	.21	.00	.03	.11	.03	.00
P3S1 Earth Science	.58	.22	.10	.07	.01	.01	.01	.00	.00
C2S1 Life Science	.08	.45	.11	.12	.05	.06	.16	.03	.00
C3S2 Life Science	.33	.35	.06	.14	.01	.06	.05	.00	.00
A1S1 Biology	.39	.33	.11	.01	.04	.02	.08	.02	.00
A2S1 Biology	.82	.12	.05	.00	.00	.00	.00	.00	.00
F3S2 Biology	.50	.39	.06	.03	.01	.01	.01	.00	.00

Table 5.19 Continued

Course Location and Title	Mem. Facts	Under-stand	Col. Data	Order/ Est.	Routine Proced.	Routine Prob.	Inter. Data	Novel Prob.	Theory/ Proof
M2S2 Biology	.38	.43	.02	.03	.05	.03	.04	.03	.00
M3S2 Biology	.56	.21	.11	.05	.02	.02	.01	.01	.00
P1S1 Biology	.34	.34	.29	.02	.00	.00	.01	.01	.00
P1S2 Biology	.37	.58	.02	.00	.00	.02	.01	.00	.00
P2S1 Biology	.52	.40	.04	.01	.01	.02	.00	.00	.00
P2S2 Biology	.03	.51	.01	.00	.00	.30	.01	.14	.00
P3S2 Biology	.15	.72	.09	.03	.00	.00	.01	.00	.00
S3S2 Modern Biology	.39	.49	.07	.00	.01	.01	.00	.00	.00
C1S2 Human Biology	.19	.79	.01	.00	.01	.00	.00	.00	.00
A3S1 General Chemistry	.09	.31	.22	.12	.08	.12	.04	.02	.00
S1S2 C.P. Chemistry	.12	.50	.09	.03	.07	.08	.07	.04	.01
M1S2 Ecology	.25	.22	.10	.25	.02	.01	.14	.01	.01

theories/develop proofs, because there is virtually no attention given to either content area. One physical science course (F3S1) stands out as an exception, allocating .04 of instructional time both to novel problems and to building and revising theory. Biology (P2S2) also stands out by allocating .14 of instructional time to novel problems.

Nearly half the sample of courses allocated approximately 10 percent of instructional time to collecting data; an additional three courses allocated from .16 to .29 instructional time to collecting data. In contrast, however, little to no time was allocated to data collection activities for a third of the courses.

Seven of the 30 courses gave significant attention, at least 10 percent ranging up to 25 percent of instructional time, to order, compare, estimate, approximate. A similar number of courses allocated from 10 percent to 30 percent of instructional time to "solve routine problems, replicate experiments/replicate proofs." In contrast, however, for each of these two levels of Dimension D, more than half of the sample of courses gave essentially no coverage at all.

Perhaps not surprisingly, there was relatively less time given to interpreting data than there was to collecting data. Still, four courses in the sample allocated 10 percent or more of instructional time to data interpretation.

Throughout Table 5.19, the pattern is more one of variation among courses than consistency across courses. Thus, the standard deviations by course type in Table 5.20 are substantial. General science courses have a relatively high mean of .74 for understand concepts but a large standard deviation of .259. Between memorizing facts and understanding concepts, 88 percent of instructional time for general science courses is accounted for, while these two levels of Dimension D account for only 50 percent of instructional time in chemistry courses. Similarly, chemistry courses stand out from the other course types as putting relatively more emphasis on the other levels of Dimension D, suggesting a more active role for students in constructing knowledge. The other course types--

Table 5.20

Dimension D Means and Standard Deviations by Course Type for Science Courses

Course Type	n	Mem. Facts		Under-stand		Col. Data		Order/ Est.		Routine Proced.		Routine Prob.		Inter. Data		Novel Prob.		Theory/ Proof	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
General Sci	2	.14	.137	.74	.259	.03	.013	.05	.073	.01	.010	.01	.020	.02	.029	.00	.002	.00	.000
Physical Sci	8	.31	.254	.37	.117	.08	.049	.04	.036	.03	.033	.08	.053	.06	.071	.02	.013	.01	.014
Earth Sci	3	.35	.209	.42	.266	.07	.041	.09	.105	.00	.006	.01	.017	.04	.063	.01	.018	.00	.000
Life Sci	2	.21	.175	.40	.075	.08	.038	.13	.018	.03	.026	.06	.002	.08	.032	.02	.024	.00	.000
Biology	12	.39	.208	.44	.192	.07	.077	.01	.016	.01	.017	.04	.084	.02	.022	.02	.040	.00	.001
Chemistry	2	.10	.021	.40	.132	.15	.088	.07	.066	.08	.011	.10	.024	.05	.019	.03	.011	.00	.005
Ecology	1	.25	.000	.22	.000	.10	.000	.25	.000	.02	.000	.01	.000	.14	.000	.01	.000	.01	.000

physical science, earth science, life science, and biology–stand between these two extremes of general science courses and chemistry courses. They put quite heavy emphasis on memorizing facts and understanding concepts, much more than chemistry courses but not so much as general science courses. Similarly, they put relatively little emphasis on the other levels of Dimension D, less than chemistry courses but not so little as general science courses. The single ecology course in the sample looks more like chemistry on levels of Dimension D than it does like the other courses in the sample. Significant instruction is devoted to the collection and interpretation of data (.24), and the ecology course gave the most emphasis to order, compare, estimate, approximate of any of the courses in the sample.

This picture of science courses portrayed through Tables 5.19 and 5.20 is at odds with the sketch of science instruction presented in Science for All Americans. There they state,

> Teaching related to scientific literacy needs to be consistent with the spirit and character of scientific inquiry and with scientific values. This includes starting with questions about phenomena rather than with answers to be learned; engaging students actively in the use of hypotheses, the collection and use of evidence, and the design of investigations and processes; providing students with hands-on experience with mechanical, electronic, and optical tools; placing a premium on students' curiosity and creativity; and frequently using a student team approach to learning. (p. 11, Summary for Project 2061 Science for All Americans)

If science courses are to come into alignment with the vision from Science for All Americans, much less emphasis will need to be given to memorizing facts and understanding concepts through instruction that emphasizes verbal and written exposition. Much more emphasis will need to be given to active learning involving collecting and interpreting data, replicating and designing experiments, and building and revising theory. Undoubtedly this change will involve significantly more lab work and field work. Unfortunately, it will also require significantly more resources. At least for the schools in this study, lab space was at a premium. Efforts by states to increase the numbers of students taking lab science courses were running up against a serious shortage of lab space available. Lab space alone, however, would not likely solve the problem. Teachers who have taught for years lecturing from textbooks that value memorization over all other forms of knowing would undoubtedly find making a dramatic shift toward more active student learning a great challenge both to their subject matter knowledge and their repertoire of pedagogical skills.

Table 5.21 presents means and standard deviations on Dimension D-like data from the questionnaire sample. The four levels of Dimension D in the questionnaire data are: memorize facts/definitions/equations only; solve routine problems, replicate experiments; interpret data, solve novel problems, design experiments; and build and revise theory, develop proofs. Also in Table 5.21 are means on the HOT scale, with a total sample (math and science combined) mean of zero and total sample standard deviation of 1.0. In several ways, the questionnaire sample data in Table 5.21 confirm on a larger sample of courses the findings from the log sample reported in Table 5.20.

Biology courses were found to put the greatest emphasis on memorizing facts (.32, .276) and the least emphasis on higher order thinking (-.12, .826). These findings for biology are consistent with those from log data. Together they suggest that, of all high school science courses, biology courses may present the greatest challenge to implementation of curriculum reform calling for more active student learning and greater emphasis on higher order thinking and problem solving. Folklore says that there is more new vocabulary to be memorized in a freshman biology course than in a first-year French course. Our data are not inconsistent with this folklore.

Questionnaire sample earth science courses and ecology courses are also relatively high in their emphasis on memorizing facts, and that was true, although slightly less so, for the log data. Questionnaire data also replicate the finding that chemistry courses have a relatively low emphasis on

Table 5.21

Questionnaire Sample Expected Student Outcomes
Means and Standard Deviations by Course Type for Science Courses

Course Type	*n*	Mem. Facts		Routine Prob.		Novel Prob.		Theory/ Proof		HOT[a]	
		$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*	$\bar{X}$	*s*
General Sci	15	.18	.200	.47	.315	.24	.323	.11	.226	.44	1.281
Physical Sci	21	.08	.118	.57	.281	.30	.292	.04	.103	.44	.840
Earth Sci	5	.17	.161	.68	.252	.15	.210	.00	.000	-.07	1.022
Life Sci	6	.08	.061	.48	.294	.37	.247	.08	.072	.15	.544
Biology	33	.32	.276	.38	.249	.20	.228	.11	.207	-.12	.826
Chemistry	13	.11	.204	.47	.286	.30	.304	.12	.275	.46	1.028
Physics	14	.09	.157	.41	.355	.31	.319	.19	.355	.60	.872
Ecology	5	.29	.288	.39	.127	.26	.162	.06	.071	.38	.814
Not Grouped	18	.09	.124	.46	.285	.34	.275	.13	.179	.49	.943
Total	130	.17	.216	.46	.285	.27	.272	.10	.210	.29	.946

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[a] HOT is a scale with grand mean zero and standard deviation equal to 1.0.

memorizing facts (.11, .204). Similarly, physics courses, which were not represented in the log sample, are found in the questionnaire data to have relatively low emphasis on memorizing facts (.09, .157). The questionnaire sample general science course emphasis on memorizing facts (.18, .200) is also quite similar to that for the log data (.14, .137). Two course types for which questionnaire data challenge the log data findings for emphasis on memorizing facts are physical science and life science. Both of these course types place a .08 emphasis on memorizing facts based on the questionnaire sample; this emphasis is substantially lower than was the case for either course type in the log data. Very likely, these differences stem more from methodological differences in the way that the variables were defined between the two data sets than any real differences. Questionnaire respondents were instructed to indicate "memorize facts" when that was the only level of Dimension D that served as an appropriate expected student outcome for a particular AB topic. Apparently for physical science and life science courses, there is some emphasis on memorizing facts for most AB topics, but not exclusive emphasis. Thus, respondents indicated on their questionnaires that instruction involved replication of experiments, designing experiments, or building and revising theory.

The fractions of instructional time devoted to build and revise theory, develop proofs in the questionnaire sample was higher than in the log sample for every course type except earth science. In the case of earth science, questionnaire data show that no instructional time was devoted to building and revising theory, developing proofs. In the log data, none of the course types devoted time to theory/proof. In the questionnaire data, physics courses put the greatest emphasis on theory/proof (.19, .355). No other pattern emerges in Table 5.21 for course type means on theory/proof. Probably the lack of pattern is the result of section to section variation as seen in the large standard deviations.

There are no clear patterns to be seen from the instructional emphases given to solve routine problems, replicate experiments; or interpret data, solve novel problems design experiments. For all science course types, the bulk of instruction was reported as falling in one or the other of these two categories. For each course type, there was more emphasis on the routine than on the novel, as one would expect. There is no evidence to suggest that higher level courses place greater emphasis on interpreting data, solving novel problems, and designing experiments than do lower level courses.

On the HOT scale, physics courses score the highest, with a relatively low standard deviation (.60, .872). Chemistry courses also score relatively high, but with a fairly large standard deviation (.46, 1.028), as do general science (.44, 1.281) and physical science courses (.44, .840). There is no pattern in the questionnaire HOT data for advanced courses to have a greater emphasis on higher order thinking and problem solving than beginning courses.

Required Science Courses Described by Dimension D. The required freshman chemistry/physics course in one Arizona urban school, A2S2, looks quite like physical science courses in general on Dimension D and also quite like the college prep physical science course in the South Carolina urban school, S1S1. On the one hand, little to no attention is given in any of these courses to novel problems or building and revising theory. On the other hand, all of these courses are dominated by an emphasis on memorizing facts and understanding concepts. Nevertheless, there are two ways, in terms of Dimension D, in which A2S2 stands out. First, the course placed less emphasis on memorizing facts than did physical science courses in general, .20 for the required course versus .31 for the physical science course sample (with a standard deviation of .254). A2S2 also put much less emphasis on memorization of facts than did S1S1 (.59). With the freed up time from a relatively lower emphasis upon memorization of facts, the required freshman chemistry/physics course put substantially more time on solving routine problems and replicating experiments, .14 for the required course versus .03 for the college prep physical science course, and (.08, .053) for the sample of physical science courses. These differences make the required course look more in line with what current curriculum reform is calling for than other physical science course.

Mathematics/Science Comparisons

Because Dimension C and Dimension D of the content taxonomy are defined in the same ways for both mathematics and science, it is possible to compare the two subject matter areas on these two dimensions. The same is also true of the HOT scale, which indicates the degree to which instruction emphasized higher order thinking and problem solving work. Table 5.22 presents means and standard deviations for mathematics and science for each level of Dimension C, each level of Dimension D, and the HOT scale.

The differences between mathematics and science on Dimension C, instructional strategies, agree with what one might expect. Science emphasizes more lab work and mathematics emphasizes more equations and formulas. While the differences are in the predicted direction, the magnitudes are perhaps less than one might expect. Science courses use lab work 10 percent of instructional time, only 8 percent more than mathematics courses. In the other direction, mathematics courses use equations and formulas .24 of instructional time, only .19 more than science courses. There was also a difference between the two subject areas in their use of pictorial models, with science using pictorial models 15 percent of the time (.15, .081) and mathematics using them only 8 percent (.08, .117). This difference probably reflects the heavy emphasis upon computation in mathematics.

Dimension D differences between mathematics and science are especially striking. Science has a much heavier emphasis on memorizing facts (.31, .212) than does mathematics (.09, .101). Similarly, science has a somewhat heavier emphasis on understanding concepts (.43, .186) than does mathematics (.30, .226). Most of these differences are made up by mathematics' much heavier emphasis upon computation (.39, .272) and solving routine problems (.15, .131); science courses

Table 5.22

Instructional Strategies and Expected Student Outcomes*
Means and Standard Deviations by Subject

Dimension C: Instructional Strategies	Math		Science	
	$\bar{X}$	S	$\bar{X}$	S
Exposit.	.56	.243	.64	.153
Pic. Models	.08	.117	.15	.081
Conc. Models	.07	.114	.05	.050
Equat./Form.	.24	.219	.05	.061
Graph	.04	.038	.01	.021
Lab Work	.02	.059	.10	.067
Field Work	.00	.000	.01	.014
Dimension D: Expected Student Outcomes				
Mem. Facts	.09	.101	.31	.212
Understand	.30	.226	.43	.186
Col. Data	.02	.029	.08	.062
Order/Est.	.01	.013	.05	.065
Routine Proced.	.39	.272	.02	.027
Routine Prob.	.15	.131	.05	.065
Inter. Data	.02	.037	.04	.051
Novel Prob.	.02	.026	.02	.027
Theory/Proof	.00	.009	.00	.008
HOT	-.25	.980	.29	.946

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*Entries in table are proportions of instructional time for a full school year and averaged over courses studied.

gave little emphasis to these two levels of Dimension D, (.02, .027) and (.05, .065).

The differences between mathematics and science are most sharply defined on the Higher Order Thinking scale (HOT). The HOT scale, developed across mathematics and science courses combined, has been standardized for a total sample mean of zero and standard deviation of 1.0, the math questionnaire sample mean on HOT was -.25, with a standard deviation of .980, while the science questionnaire sample mean was .29, with a standard deviation of .946. Thus, on average, science courses are one-half standard deviation more oriented toward emphasizing higher order thinking and problem solving than are the mathematics courses. Further, as noted earlier, with the exception of calculus (.32), all of the science course types had higher average HOT means than any of the math course types. With the exception of Calculus, the most HOT math course, Algebra 2, was not as HOT as the least HOT science course, Biology.

The Pedagogy of High School Mathematics and Science

In addition to describing the content of instruction using content taxonomy distinctions represented by taxonomy Dimensions A, B, C, and D, daily logs also provide information on pedagogical strategies. Obviously, the distinction between content and pedagogy is not clear-cut. While virtually everyone would agree that taxonomy Dimensions A and B represent content, some might argue that Dimensions C and D are at least as much pedagogy as content. The distinction between content and pedagogy made here is more a distinction for convenience of reporting than it is a substantive distinction.

On the daily logs, teachers reported the number of minutes of noninstructional time. Noninstructional time was a piece of information added to the logs after the first semester of use. The question asked on the logs was, "How many minutes of this class period were spent on activities not directly related to learning the academic content of this course? (e.g., announcements, attendance, establishing rapport, handling disruptions, etc.)." Teachers also reported on daily logs the modes of instruction used that day and what activities students were engaged in. For each mode of instruction or student activity, the teacher indicated the degree of emphasis, with emphasis codes comparable to those used in reference to ABCD content topics taught. Emphasis codes for modes of instruction and student activities were converted to fractions of instructional time just as emphasis codes were converted to fractions of instructional time for content topics. Finally, teachers indicated on daily logs the instructional materials they used that day as well as the nature of any homework assigned.

This section of the report provides means and standard deviations by subject and course type for these pedagogical practices described in the logs. In addition, two variables were created to describe the breadth and depth of content coverage. Breadth was defined as simply the number of AB topics taught, at least to some degree. Breadth defined by number of AB topics was available from both the log data and the questionnaire data. For the log data, number of AB topics was standardized to a 180-day school year so that variance in the number of log days of data would not create instability across teachers in the variable. Depth of instructional coverage was defined for log data as the average number of Dimension C by Dimension D combinations used in conjunction with each AB topic. For the questionnaire data, this definition was not possible. Instead, depth was defined as the average weight teachers gave each AB topic taught, with weights defined on a 3-point scale described previously: less than 2 hours, 2 to 10 hours, 10 or more hours.

Depth and Breadth of Coverage

Table 5.23 presents means and standard deviations by subject and by course type for the variable breadth of coverage and the two different definitions of the variable depth of coverage, one for the log sample and the other for the questionnaire sample. Before attempting to interpret the data in Table 5.23, some caveats are necessary.

Table 5.23

Depth and Breadth of Coverage by Subject and Course Type

Course Type	Log					Questionnaire				
	n	Breadth[a]		Depth[b]		n	Breadth[a]		Depth[c]	
		$\bar{X}$	s	$\bar{X}$	s		$\bar{X}$	s	$\bar{X}$	s
Math	32	28.2	9.62	3.2	1.18	150	27.6	13.43	2.0	.46
Basic Math	8	29.9	11.46	2.4	.61	50	24.8	11.88	2.0	.50
Prealgebra	5	32.8	3.90	2.7	.59	13	26.8	12.23	2.0	.37
Algebra 1	11	23.7	9.07	3.8	1.31	25	26.6	10.05	1.9	.40
Algebra 2	4	25.7	11.03	4.0	1.43	20	30.8	14.61	2.1	.49
Geometry	3	30.6	3.60	3.4	.92	14	24.6	15.89	1.9	.40
Trig/Precalc	1	45.0	.00	2.3	.00	12	37.8	18.02	2.1	.52
Calculus	0	–	–	–	–	6	29.3	12.32	1.8	.43
Not Grouped	0	–	–	–	–	10	29.8	14.94	1.8	.35
Science	30	30.6	11.55	4.1	1.82	130	21.2	14.57	1.9	.42
General Sci	2	46.8	2.55	3.1	2.50	15	18.8	17.21	1.9	.47
Physical Sci	8	24.3	9.86	5.3	2.40	21	15.5	7.37	2.0	.37
Earth Sci	3	22.2	5.20	3.1	.88	5	8.4	2.89	2.2	.52
Life Sci	2	23.4	2.55	3.6	.64	6	32.2	14.69	1.9	.41
Biology	12	36.0	9.37	3.4	1.00	33	31.5	12.18	1.7	.36
Chemistry	2	18.0	2.55	5.8	2.43	13	12.2	8.99	2.1	.39
Physics	0	–	–	–	–	14	12.4	9.08	2.1	.41
Ecology	1	48.6	.00	5.0	.00	5	32.6	24.77	1.8	.27
Not Grouped	0	–	–	–	–	18	21.2	13.64	2.0	.40

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[a] Number of AB topics taught.

[b] Average number of CD combinations per AB topic.

[c] Average weight per AB topic (weighted on a 1 to 3 scale).

Breadth of coverage, the number of AB topics taught, is a highly unstable variable. An AB topic is considered to have been taught if it receives at least an emphasis code of 1 for one day of instruction in the daily logs, or, in the case of questionnaire data, if it is taught at all, even if only for a few minutes of time over the course of a full school year. Since the distinction between counting an AB topic as a part of breadth or not is so slight, the chance for errors in reporting are great.

The depth of coverage variables do not suffer from this instability to quite the same extent. In the case of log data, depth is defined as the average number of CD combinations per AB topic; this average across all AB topics creates stability. In the case of questionnaire data, depth is the average emphasis weight given per AB topic; again, the averaging creates stability.

Another caveat when interpreting the data in Table 5.23 is that for mathematics the taxonomy lists 94 different AB topics, while for science the taxonomy lists only 68 AB topics. Exactly half of the science AB topics are in the area of biology. Thus, by definition, there is greater opportunity for breadth in the mathematics area than in the science area. Within science, there is greater opportunity for breadth in courses that teach biology than for courses that do not. These differences in the language for reporting content make it necessary to be careful when interpreting differences between the two subjects and, in science, between biology courses and other courses.

For the target sample, log data show that general science with 46.8 topics of the possible 68 science topics taught at least to some extent and ecology with 48.6 had the greatest breadth of any course in either the mathematics or the science sample. In contrast, chemistry was the most focused, with an average of 18 topics taught. This finding of focus for chemistry is consistent with the earlier finding that the largest fraction of instructional time in chemistry courses was spent on chemistry content. Biology also had a relatively high breadth of coverage, with a mean of 36 but a large standard deviation of 9.37. Math courses had less breadth of coverage, with a mean of 28.2, than did science courses, with a mean of 30.6, despite the fact that the taxonomy for mathematics had nearly

50 percent more topics than did the taxonomy for science. Within the math sample, no differences among course types are particularly striking, at least on log data. The single trig/precalculus course covered, at least to some extent, 45 of the possible 94 AB topics in mathematics. While this was the greatest breadth for course types within mathematics, it was based on only a single course.

When looking at depth of coverage for the target sample, science courses covered content with greater depth than did math courses (more than a half standard deviation difference regardless of whether you used the much larger standard deviation for science, 1.82, or the smaller standard deviation for mathematics, 1.18). Given the definitions of depth and breadth, there is some reason to expect a negative correlation between the two, but that correlation was far from perfect. At the subject level, science courses had both greater breadth and greater depth than math courses. When looking within science course types, however, greatest depth was for chemistry courses (5.8), and chemistry was the course type with the least breadth. But earth science and general science each had the same 3.1 depth of coverage, while general science had breadth of coverage 46.8 and earth science had only 22.2 for breadth of coverage.

The most striking finding for depth of coverage on log data is not differences between the two subjects or differences among course types within subjects. Rather, the most striking finding is that there was little depth for either subject or any course type. By definition depth could have ranged to as high as 63 (seven levels of Dimension C times nine levels of Dimension D). In contrast, the actual depth of coverage for the target sample was much, much smaller. This finding of lack of depth vividly illustrates findings reported previously for Dimensions C and D. Depth, by looking at the two dimensions in combination, strikingly illustrates how few different modes of instruction and different types of expected student outcomes teachers included in their instruction. Clearly, the instruction in our sample of courses is extremely narrow and limited in comparison to what it might be. Students are not given sufficient opportunity to learn topics in different ways or to use their knowledge for application and reasoning so that they become accomplished in the subjects they study.

For mathematics, the questionnaire data on breadth largely confirm the log data on breadth. The standard deviations in the questionnaire sample are larger than for the log data, as one would expect because of the unstable nature of the variable and the larger questionnaire sample size. But the questionnaire and log means are quite consistent overall and course type by course type. For science, consistency between questionnaire and log data on breadth was not nearly so great as for mathematics. Questionnaire data means on breadth bounce around, with average breadth as small as 8.4 for the five earth science courses and as large as 32.6 for the five ecology courses. Generally, average breadth by course type is lower for the questionnaire data than the log data. In some cases, the difference is striking. For example, average breadth on general science for log data was 46.8 but only 18.8 for questionnaire data. The relatively large breadth of coverage for biology in the log sample, however, was confirmed by the 31.5 mean for the 33 biology courses in the questionnaire sample.

No direct comparison between questionnaire sample and target sample data is possible on depth, since depth was defined in different ways for the two samples. Depth of coverage for the questionnaire sample was a function of the average amount of time per AB topic spent, not, as for the target sample, the number of different ways an AB topic was taught. No real differences between subjects or among course types emerge in Table 5.23 for depth of coverage based on the questionnaire sample.

Noninstructional Time

On each daily log, teachers reported the number of minutes of the class period that was used for noninstructional purposes. Some of these noninstructional activities were required, such as taking attendance, but others represented wasted time during which teachers and students were talking about topics unrelated to the course, such as sports, and times when teachers were simply trying to get students to sit down and pay attention so that the class could begin. Table 5.24 presents means and standard deviations for noninstructional time by subject and by course type.

For the target sample, noninstructional time accounted for slightly less total instructional time for math (4.9) than for science (5.9), and the amount of noninstructional time varied less in mathematics (standard deviation of 2.39) than in science (standard deviation of 3.26). Within the subject matter areas, there was a tendency for noninstructional time to be more associated with basic courses than advanced courses. For example, in the math sample, the highest mean was for basic math (6.4), and the lowest mean was for the single trig/precalculus course (2.7). Further, within mathematics, of the 32 course sections studied, 2 had an average amount of noninstructional time per class of 10 minutes or more; both of those were basic math courses. In science, of the 30 course sections studied, 5 had average noninstructional time per class exceeding 10 minutes. Of these, two were physical science courses, two were biology courses, and one was a life science course. For one of the two physical science courses, the average amount of noninstructional time was as high as 14.5 minutes per period. In contrast, the two chemistry courses had an average amount of noninstructional time of 1.6 per class period. Thus, while the relationship was not quite as strong for science as for math, even in science there was a tendency for more noninstructional time in lower level courses than in higher level courses.

These amounts of noninstructional time, self-reported by teachers on daily logs, are worrisome. A class that has on average 10 minutes per period devoted to noninstructional activities is a class not using for instruction a full 20 percent of the time it has been allotted. Over the course of a 180-day school year, 10 minutes per period of noninstructional time becomes seven weeks of class meetings with no instruction. In a nine-month school year, this is nearly two months allocated to instructional time devoted to noninstructional purposes. Even five minutes per course period is

Table 5.24

Minutes of Noninstructional Time Per Class Period by Subject and Course Type

	n	$\bar{X}$	*s*
Math	32	4.9	2.39
Basic Math	8	6.4	2.50
Prealgebra	5	4.1	2.24
Algebra 1	11	4.3	2.73
Algebra 2	4	4.7	1.10
Geometry	3	5.2	1.17
Trig/Precalc	1	2.7	.00
Science	30	5.9	3.26
General Sci	2	3.8	2.69
Physical Sci	8	6.9	4.10
Earth Sci	3	5.6	2.38
Life Sci	2	8.1	3.51
Biology	12	6.0	2.79
Chemistry	2	1.6	2.22
Ecology	1	8.0	.00

troublesome. Over a 180-day school year, five minutes aggregates to three and a half weeks of noninstructional time, or nearly one month out of nine. The physical science class in the Missouri urban high school, with its average of 14.5 minutes of noninstructional time per period, is a travesty.

Several education reformers have suggested that a way to improve student achievement is to lengthen the school year. The report A Nation At Risk (1983) recommends a 200- to 220-day school year. Several of the course sections studied here are wasting as much time within the current 180-day school year as would be added through their recommendation. In the same Missouri high school, the other two classes in the target sample had noninstructional time averages per period of 10.07 and 8.02 minutes for a school average of over 10 minutes per period. For courses that are already wasting large fractions of the time that they have been allotted, the concept of extending the school year makes little sense.

Modes of Instruction

Table 5.25 presents means and standard deviations by subject and by course type for each of the six modes of instruction listed as alternatives on the daily log: lecture, demonstration, recitation/drill, class discussion, small groups, seat work. Perhaps the first thing to notice from Table 5.25 is the very large means for seat work. For all of the course types except earth science, seat work represented one-third or more of total instructional time. The two subject matter areas were exactly equal in the use of seat work, on average 35 percent of instructional time. In mathematics, there was twice as much demonstration (.17, .076) as in science (.08, .043). Also in mathematics there was slightly less lecture (.18, .084) than in science (.23, .133). The two subject matter areas were, on average, nearly identical in their use of recitation/drill, class discussion, and small groups.

For mathematics, there was some tendency for the amount of time spent in lecture and seat work to be less for more advanced courses than for basic courses; there is no evidence of such a

Table 5.25

Modes of Instruction Means and Standard Deviations

Course Type	n	Lecture		Demonstration		Recitation/ Drill		Class Discussion		Small Groups		Seat Work	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
Basic Math	8	.19	.100	.10	.050	.06	.063	.10	.081	.12	.116	.43	.166
Prealgebra	5	.15	.033	.18	.108	.09	.076	.06	.052	.09	.084	.42	.210
Algebra 1	11	.18	.103	.18	.071	.06	.052	.14	.085	.12	.103	.32	.112
Algebra 2	4	.15	.052	.16	.023	.10	.056	.15	.151	.11	.090	.31	.117
Geometry	3	.18	.071	.22	.032	.06	.044	.10	.032	.18	.109	.26	.111
Trig/Precalc	1	.29	.000	.28	.000	.03	.000	.08	.000	.00	.000	.31	.000
Total Math	32	.18	.084	.17	.076	.07	.057	.11	.086	.12	.099	.35	.148
General Sci	2	.22	.163	.07	.056	.10	.080	.09	.089	.11	.141	.42	.203
Physical Sci	8	.16	.070	.07	.039	.06	.047	.21	.080	.13	.076	.36	.097
Earth Sci	3	.34	.229	.06	.066	.06	.051	.24	.149	.13	.114	.16	.139
Life Sci	2	.12	.144	.11	.031	.07	.068	.14	.059	.10	.123	.46	.307
Biology	12	.28	.125	.08	.042	.06	.035	.14	.094	.09	.047	.35	.084
Chemistry	2	.15	.040	.12	.072	.05	.066	.07	.001	.18	.070	.42	.081
Ecology	1	.16	.000	.08	.000	.06	.000	.18	.000	.06	.000	.46	.000
Total Science	32	.23	.133	.08	.043	.06	.043	.16	.096	.11	.073	.35	.129
Total	62	.20	.112	.13	.075	.07	.050	.14	.094	.11	.087	.35	.138

pattern in science. For all but two mathematics course types, Algebra 2 and geometry, lecture and seat work combined accounted for more than 50 percent of total instructional time. In mathematics, however, demonstration also is likely to be much like lecture, with the most common format being the teacher working a problem at the board. In mathematics, demonstration accounts for an additional 17 percent of instructional time. In contrast to the heavy emphasis on lecture, seat work and mathematics demonstrations, two modes of instruction emphasized as important in the NCTM *Standards* and in the AAAS Science for All Americans, class discussion and use of small groups, receive in combination only approximately 25 percent of instructional time. Almost certainly today's curriculum reformers would like to see a reduction in the amount of seat work and an increase in class discussion and perhaps an increase in small group work.

Student Activities

Table 5.26 presents means and standard deviations by subject and by course type for the several types of student activities represented on the daily logs: listen/take notes, discuss/discovery lesson, complete written exercises/take a test, write report/paper, lab or field work, present/demonstrate. The data for student activities has considerable overlap with data reported previously for Dimension C of the taxonomy and also the modes of instruction data just reported. Largely these three sources of data are consistent when they address the same phenomenon.

In mathematics, the fractions of instructional time for students' listening and taking notes is in all cases larger than the fraction of time reported in Table 5.25 for teacher lecturing. This supports the speculation that mathematics demonstration consisted largely of the teacher working at the board, and students listening and taking notes. Students listening and taking notes also occurred a larger fraction of the time for science courses than did lecturing occur for science courses, despite the fact that the fraction of time spent on demonstrations in science courses was relatively modest in

Table 5.26

Student Activity Means and Standard Deviations

Course Type	n	Listen/ Take Notes		Discuss		Exercises/ Test		Write		Lab/ Field Work		Present/ Demonstrate	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
Basic Math	8	.26	.095	.14	.102	.51	.182	.01	.008	.03	.057	.05	.055
Prealgebra	5	.29	.083	.10	.083	.49	.188	.01	.017	.02	.052	.08	.118
Algebra 1	11	.30	.063	.21	.096	.40	.095	.00	.003	.00	.008	.08	.079
Algebra 2	4	.26	.141	.20	.117	.37	.151	.00	.001	.01	.011	.15	.138
Geometry	3	.32	.007	.22	.129	.42	.135	.01	.007	.02	.016	.01	.015
Trig/Precalc	1	.51	.000	.09	.000	.34	.000	.00	.000	.00	.000	.06	.000
Total Math	32	.29	.090	.17	.104	.44	.146	.00	.008	.01	.035	.07	.087
General Sci	2	.30	.188	.08	.039	.43	.013	.06	.010	.11	.108	.02	.018
Physical Sci	8	.24	.051	.22	.103	.33	.134	.05	.048	.09	.068	.06	.042
Earth Sci	3	.41	.230	.26	.108	.20	.168	.02	.001	.07	.078	.03	.055
Life Sci	2	.20	.083	.19	.091	.38	.213	.03	.021	.18	.010	.02	.028
Biology	12	.37	.090	.20	.072	.32	.067	.01	.006	.08	.046	.02	.024
Chemistry	2	.21	.117	.14	.108	.33	.135	.04	.019	.16	.090	.12	.072
Ecology	1	.26	.000	.23	.000	.33	.134	.06	.000	.11	.000	.01	.000
Total Science	32	.31	.121	.20	.089	.32	.000	.03	.033	.10	.064	.04	.044
Total	62	.30	.106	.18	.097	.38	.142	.02	.027	.05	.065	.06	.071

comparison to mathematics. Even so, for each science course type, when the means for lecture and demonstration in Table 5.25 are added together, they come very close to equaling the means for listen/take notes in Table 5.26.

The means for discuss in Table 5.26 include discovery lessons as well, while the class discussion means in Table 5.25 are defined only in terms of whole-class discussion. This difference in definition of the two variables explains why the discuss means in Table 5.26 are slightly larger than the class discussion means in Table 5.25. The large means in Table 5.26 for students completing written exercises/taking a test are consistent with the high means for seat work in Table 5.25.

Virtually no mathematics instructional time is allocated to students writing, and in science only 5 percent or less of instructional time is devoted to student writing. While this is consistent with data reported elsewhere in this report, it is certainly at odds with present day curriculum reforms calling for students to be more actively engaged in their own instruction and more involved in constructing their own knowledge.

The means for lab or field work in Table 5.26 correspond almost exactly with the lab work and field work means combined as reported in Table 5.6 for Dimension C of mathematics and Table 5.18 for Dimension C of science and the summaries for math and science in Table 5.22. Lab and field work receive essentially no instructional time in mathematics courses and on average 10 percent of the instructional time in science courses. Chemistry courses had the highest fraction of instructional time for lab and field work.

Students made presentations/demonstrations for approximately 5 percent of instructional time, with the exception of four Algebra 2 classes in which students presented/demonstrated to the class on average 15 percent of instructional time. These means should not be compared to the demonstration means reported in Table 5.25, since in Table 5.25 the data describe modes of instruction for teachers and students combined. In Table 5.26, the data are describing student activities alone.

Instructional Materials and Homework

Table 5.27 presents the means and standard deviations by subject and course type for the fraction of class periods during which a textbook was used, a test was given, and/or some type of homework was assigned. In describing homework, four possibilities were distinguished: homework not corrected, homework corrected, paper assigned, no homework.

The fraction of instructional days in which a textbook was used was on average just over 50 percent, but with a fairly large standard deviation (.57, .223). In mathematics, there was a tendency for textbooks to be used more frequently for advanced courses than for basic courses. In science, there was no similar relationship to be found between level of course and frequency of text usage. Science and mathematics were almost identical in the frequency of use of textbooks, with mathematics (.58, .247) and science (.55, .198).

The frequency of testing was quite similar between the two subject matter areas. Testing is done in 10 percent of class meetings, equating to roughly one test every two weeks. There was, however, some variance across course types in the reported frequency of testing. In the science sample, earth science stands out for the infrequency with which tests were given (.04), or roughly one test per month. In mathematics, there was a slight tendency for more testing in the basic courses than in the advanced courses.

Homework is much less common in science courses than it is in mathematics courses. Within mathematics courses homework is less common in the basic courses than in the more advanced courses. For mathematics, there is no homework roughly 25 percent of the time (.28, .202), but for basic math courses there is no homework over 40 percent of the time (.43, .301). In science, there is no homework over 40 percent of the time (.43, .272), but chemistry stands out as a sharp exception, with no homework approximately 10 percent of the time (.12, .111).

Table 5.27

Instructional Materials and Homework
Means and Standard Deviations

Course Type	*n*	Text		Test		Homework Not Corrected		Homework Corrected		Paper Assigned		No Homework	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
Basic Math	8	.40	.269	.16	.068	.15	.285	.42	.306	.00	.002	.43	.301
Prealgebra	5	.57	.224	.14	.025	.16	.193	.54	.349	.00	.000	.31	.179
Algebra 1	11	.64	.269	.13	.052	.19	.173	.62	.190	.00	.002	.19	.106
Algebra 2	4	.67	.098	.12	.027	.23	.215	.57	.258	.00	.003	.20	.171
Geometry	3	.73	.070	.08	.046	.11	.164	.60	.208	.00	.000	.30	.084
Trig/Precalc	1	.77	.000	.10	.000	.13	.000	.58	.000	.01	.000	.28	.000
Total Math	32	.58	.247	.13	.053	.17	.200	.55	.253	.00	.002	.28	.202
General Sci	2	.58	.007	.10	.007	.26	.084	.38	.076	.02	.034	.33	.026
Physical Sci	8	.60	.190	.11	.041	.29	.164	.23	.248	.04	.078	.44	.251
Earth Sci	3	.69	.205	.04	.040	.23	.131	.39	.306	.04	.061	.34	.406
Life Sci	2	.45	.403	.11	.035	.21	.263	.17	.099	.03	.030	.60	.391
Biology	12	.50	.187	.11	.042	.23	.202	.29	.266	.01	.010	.47	.272
Chemistry	2	.66	.283	.14	.092	.34	.421	.54	.533	.00	.000	.12	.111
Ecology	1	.40	.000	.09	.000	.22	.000	.07	.000	.03	.000	.69	.000
Total Science	32	.55	.198	.10	.046	.26	.182	.29	.261	.02	.046	.43	.272
Total	62	.57	.223	.12	.051	.21	.195	.42	.285	.01	.034	.35	.248

Of the time that homework is assigned, almost never does it involve writing a paper in mathematics, and only 2 percent of the time does it involve writing a paper in science. Still, over the course of a 180-day school year, 2 percent of the time amounts to 3.6 papers assigned. When interpreting this amount it is important to keep in mind that no distinction was made as to whether the paper was a serious paper or only a one- or two-page report. When homework other than a paper is assigned in mathematics, it is much more likely to be corrected than not corrected. In mathematics, in over half the days for which logs were kept, homework was assigned that would be corrected; for only 17 percent of the days was homework assigned that would not be corrected. In contrast, for science homework was just as likely not to be corrected as it was to be corrected. No clear patterns emerged for the frequency of homework (either corrected or not corrected) in distinguishing among the types of courses either within mathematics or within science.

Chapter 6

EXPLAINING CLASSROOM PRACTICE: WHO TEACHES WHAT MATHEMATICS AND SCIENCE CONTENT TO WHOM

Several multiple regression equations were fit to both questionnaire and log data to explain the variance among class sections studied in both the content taught and, to some extent, pedagogical strategies employed. The questionnaire sample affords the best data set for estimating regression equation parameters because of the relatively large sample size. While sample size varied somewhat across variables, there are as many as 295 course sections for which questionnaire data are available in the total sample, 156 course sections for the questionnaire math sample and 137 course sections for the questionnaire science sample. Log sample sizes are substantially smaller.

The focus in what follows is on regression equations estimated from the questionnaire data. Log sample regressions are also presented, despite small sample sizes, since teacher log data give the best information concerning classroom practices.

Several sets of regression equations were estimated and are presented. Three "policy" variables were defined. Each policy variable is used as an independent variable separately from each other policy variable. The Group policy variable is defined as a linear contrast among the six states. California and Arizona are coded 1; Missouri and Pennsylvania, 0; and Florida and South Carolina, -1. This Group variable contrasts states with the greatest emphasis on encouraging higher order thinking, problem solving, and reasoning (i.e., California and Arizona) with states that have the greatest focus on basic skills (i.e., Florida and South Carolina). The two states having the fewest state level curriculum policy initiatives in math and science are in between the two extremes (Missouri and Pennsylvania). A second "policy" variable is labelled Policy and is a scale created from questionnaire items. Policy and other scales used in the regression analyses are defined in greater detail in the next section. The third "policy" variable simply contrasts the states in the study;

Missouri is used as the reference state against which each of the other five states is contrasted. While State is obviously a crude proxy for a policy variable, each of our states did have a unique set of curriculum policies bearing on high school science and mathematics practice (as was seen in Chapter 3).

For both the questionnaire and the log sample, one set of regressions used a policy variable and a set of control variables to predict school, teacher, and class climate variables. Another set of regressions used the policy variable, the control variables, and the climate variables to predict pedagogical and content practices. The two sets of regression equations together hold out the possibility that a "policy" variable might influence a climate variable, which, in turn, influences classroom practice. The second set of regression equations estimates the direct effect of the policy variable on classroom practice. Each of these two regression models was estimated three times for each of the three "policy" variables, once on the total sample, once on the math sample, and once on the science sample.

Because the information available differed between the questionnaire and log samples, and because the log sample was too small to include all of the variables of interest, there are several differences between regression equations estimated for the two sets of data. For the questionnaire sample, the control variables are:

School Behavior
Class Ability
Course Level
Subject

The climate variables can be thought about in three sets:

School
  Leadership
  Resources
  Institutional Support
  Shared Beliefs
  Teacher Control

Class
    Percent Female
    Percent White
    Class Size

Teacher
    Responsibility
    Collegiality
    Satisfaction
    Gender
    Ethnicity
    Level of Education
    Years of Experience

For the log sample, a similar but not identical set of regression equations was estimated. The States policy variable was eliminated from the analyses due to lack of sufficient degrees of freedom. Also, the sets of control and climate variables were reduced.

For the log sample, the control variables are:
    Class Ability
    Course Level
    Subject

The climate variables are:
    Percent of Female Students in the Class
    Percent of White Students in the Class
    Teacher Years of Experience
    Teacher Level of Education
    Teacher Control

The first set of regression equations, then, uses the Group policy variable and control variables to predict climate variables for the total questionnaire sample. The next set of regression equations uses the same regression model, but with parameters estimated from the math sample. The science sample is used with the same regression model to complete the set. A second set of regressions uses the Policy variable and control variables to predict climate variables, first on the total sample, then on the math sample, and finally on the science sample. In the third set of regressions, individual states are used together with control variables to predict climate variables, first on the total sample, then for the math sample, and finally for the science sample.

The next set of regression runs uses each of the three policy variables in turn, together with control and climate variables, to predict classroom pedagogical and content practices. First, the Group policy variable is used together with control and climate variables to predict classroom practices based on the total sample. Then the same model is used with the math sample, and finally with the science sample. Next, the same three sets of regression equations are estimated, but with the Policy variable rather than the Group variable. Finally, the State variables are used together with control and climate variables to predict classroom practices, first on the total sample, then on the math sample, and finally on the science sample.

Parallel sets of regressions are estimated on the log data using the control and climate variables listed above for the log data regression models and for only policy variables Group and Policy.

In what follows, the results from fitting the various regression equations to the various samples are presented in the same order as described here. Questionnaire regressions are presented first followed by log regressions. For both the questionnaire and log regressions, the first results presented are for the Group variable together with control variables to predict climate variables for the total sample. All regression equations with significant multiple correlations at the .05 level of significance are presented. For the math and science sample regressions, however, regression equations are presented only if they offer a new finding from those found in the regression equations based on the total sample. Similarly, when moving from the Group variable to the Policy variable, only regression equations are presented that offer new findings. If the policy variable is significant, then the regression equation is presented, or if some other independent variable is significant that was not significant in the previous analyses for Group, then the regression equation is presented. The same is true when the regression equations using states are presented; only regression equations providing new information are presented.

Before reporting the results of these regression analyses, the next section provides definitions of the control and climate variables used in the questionnaire sample and log sample analyses.

Variable Definitions

Of the three "policy" variables used in the regression equations, the definitions of Group and States are straightforward and already given. The third variable, Policy, is defined by a scale constructed from eight questionnaire items (See Appendix C for the exact wording of each item, the internal consistency reliability, and the total sample means and standard deviations for each item.). Two of the items forming the scale ask about the type of influence of district testing and graduation requirements on the mathematics/science instruction in the teacher's school. On average, teachers reported essentially no influence for district testing but substantial positive influence for graduation requirements (mean one full standard deviation above the no influence midpoint on the 3-point scale). Four additional items asked teachers to rate the influence of (a) state curriculum guides, (b) district curriculum guides, (c) district tests, and (d) state tests on the instruction in their particular course being described on the questionnaire. Of the four potential influences, state and district curriculum guides were rated the highest, approximately 2.0 on a 4-point scale, with 3.0 representing a major influence and 0.0 representing no influence at all. District and state tests were seen as less influential, with means of approximately 1.5. The last two items in the scale asked teachers to indicate whether or not in the past three years there had been a change in graduation requirements or competency testing for promotion or graduation. Reflecting the fact that we studied states that had recently increased their high school graduation requirements, .58 of the teachers said a change had happened recently in graduation requirements. Also, .30 of the teachers indicated the implementation of competency testing for promotion or graduation within the last three years.

Control Variables

In addition to course level and subject, two control variables already defined, there were three additional control variables used in questionnaire regressions, two defined at the school level and one defined at the class level.

School Behavior is defined on 11 items. Nine of the items consist of student problems, and, for each, teachers were to rate how serious the problem was in their school using a 4-point scale, with 3.0 indicating no problem and 0.0 indicating a serious problem (1.5 as the midpoint). Absenteeism was seen as the most serious problem, with a total sample mean of .64. Tardiness and class cutting were the next two most serious problems with means of 1.13 and 1.16, respectively. Following that, in decreasing order of seriousness, are the problems of use of other drugs (than alcohol), with a mean of 1.41; use of alcohol (1.52), vandalism (1.68), physical conflicts among students (1.69), robbery or theft (1.80), and gang activities (1.97). The other two items forming the school behavior scale asked about the influence of student attendance and student discipline on mathematics/science instruction in the school. Both were seen as having a negative influence. On the 3-point scale, with 1.0 indicating positive influence and -1.0 negative influence, the total sample mean for student attendance was -.22, and for student discipline -.13. In each case the standard deviations were quite large, approximately .9.

School Ability is a scale defined on two items. The first asked teachers to rate the average academic ability of students when they enter the school using a 5-point scale, ranging from 2.0 for much above the national norm to -2.0 for much below the national norm. The total sample mean is -.97, with a standard deviation of .82. The second item on the scale asked teachers to rate the influence of student reading abilities on mathematics/science instruction in their school. On a 3-point scale, with 1.0 as a positive influence and -1.0 as a negative influence, the total sample mean was -.39, with a standard deviation of .86. Both of these items are consistent with the sampling design of the study; schools were selected because they served high concentrations of poor students and had relatively low overall levels of student achievement.

Class Ability is a scale comprised of four items on the questionnaire. One item asked teachers to describe their class in terms of student ability. Using a 3-point scale of 1.0 for low ability, 2.0 for average ability, and 3.0 for high ability, the total sample mean was 2.0, with a standard deviation of .55. Another item asked teachers to indicate the number of students who were repeating the course being described on the questionnaire. In the scale, this item was converted to the percent of students not repeating the class. The total sample mean of the converted item was .92 with a standard deviation of .13. A third item asked teachers to rate the overall level of student effort in the course being described on the questionnaire. On a 3-point scale, with 1.0 equalling above expectation and -1.0 equalling below expectation, the total sample mean was -.23 with a standard deviation of .6. The final item on the scale asked teachers to estimate the approximate distribution of final course grades; the total sample grade point average is 2.11 with a standard deviation of .66. In the total sample, then, the course sections described on the questionnaire were reported by their teachers to be quite average, have a relatively low fraction of students repeating the course but have a less than expected level of student effort.

For the log sample, additional information was available concerning student ability from the prelog survey. As reported in Chapter 2, a factor analysis indicated that, in addition to the questionnaire items for class ability, three prelog survey items loaded on the class ability factor: of the students in class, percent expected to graduate from high school, percent expected to graduate from college, percent expected to take more math and science than required.

School Climate Variables

Leadership is a four-item scale. On three of the items, teachers rate the extent to which (a) the mathematics/science curriculum is well coordinated, (b) the principal talks with them frequently about instructional practices, (c) the principal knows what kind of school he or she wants and has communicated it to the staff. The fourth item asks about the nature of the influence of articulation of instruction across grade levels on mathematics/science instruction in their school. Total sample averages indicate that teachers neither strongly agreed nor strongly disagreed with each of the first three statements and saw the influence of across-grade articulation as slightly positive.

Resources is a 10-item scale. The items ask whether or not materials are available as needed, about the availability of computers and other instructional resources, and the influence on mathematics/science instruction in their school of facilities, funds for equipment and supplies, and the like. For each item, the average teacher response was near the middle of the scale but slightly on the side of indicating that teachers had the resources that they needed. The exception was that computers were rated as slightly less available than teachers would like, especially when rating the availability in their own classrooms (total sample mean of 1.5 and standard deviation of .71 on a 3-point scale, with 3.0 indicating readily available and 1.0 indicating not available).

Institutional Support is a 5-item scale, asking teachers to rate the extent to which administration's behavior toward staff is supportive and whether the following had a positive or negative influence on the mathematics/science instruction in their school: teacher planning time, time to teach mathematics/science, class size, counselors. Again, on average, teachers' responses were toward the positive end of the scale, with the exception of class size, which was reported as having no influence.

Shared Beliefs is a 3-item scale. The first item asks teachers to rate the extent to which their colleagues share their beliefs and values about the central mission of the school. The average response on a 6-point scale was a slightly positive 3.9 (standard deviation of 1.16), where 1.0 equals strongly disagree and 6.0 equals strongly agree. The other two items ask teachers to rate whether in their school as a whole the influence on mathematics/science instruction was positive or negative concerning a belief in the importance of mathematics/science when compared to other subject areas and teacher interests in mathematics/science. Both were reported as strong positive influences, with total sample means of .70 and .82, respectively, on a 3-point scale, where 1.0 equals positive influence and -1.0 equals negative influence. These findings are somewhat surprising and may indicate that the respondents interpreted the item to ask what the influence of the two factors are in theory rather than their actual level in the teacher's school.

Teacher Control is an 18-item scale. Items ask teachers to indicate, on the one hand, the degree to which they are involved in making decisions about what will be taught in their courses and the actual influence teachers have over various school curriculum policies and practices and, on the other hand, the extent to which school and district policies and administrators influence the content of their mathematics/science course being described on the questionnaire. On average, teachers agree more than they disagree that they are involved in making decisions about what will be taught in their courses. They feel they have more influence on establishing the curriculum than they have on policies concerning student grouping and what courses students should take. They report having substantial control over both what is taught and the pedagogical practices that they employ in their own classroom. The control over pedagogical practices is described as, on average, nearly "complete control," while the control over content is slightly less. Of all the influences on classroom instruction investigated in this set of items, principals were seen to have the least influence, with a total sample mean of 3.1 on a 4-point scale from 1.0 equal major influence to 4.0 equal no influence. The next least influential factor as reported by teachers was districtwide tests, with a mean of 2.94 (on the same scale), and the greatest influence was course textbook, with a mean of 1.83. The two reported greatest influences on the content of mathematics/science taught in the course sections being described on the questionnaire are course textbook and teachers' own beliefs, with textbooks being, on average, nearly a half a standard deviation greater in reported influence than teachers' own beliefs.

Teacher Climate Variables

There are five teacher climate variables.

Level and Amount of Education is a scale based on six questionnaire items reflecting level of college degrees, whether a major or a minor was completed in a field relevant to the course section being described in the questionnaire, and whether the teacher was certified to teach that course. The scale is also a function of the number of credits completed in mathematics or mathematics education for math teachers and in science or science education for science teachers.

Load, a 3-item scale, is a function of how many hours per week the teacher was assigned to teach (total sample mean of 21.9 and a standard deviation of 6.9), the total number of students taught per day (total sample mean of 122.4 and a standard deviation of 35.46), and the number of hours per week free for lesson planning and class preparation (total sample mean of 5.6 and a standard deviation of 3.1). (Planning time was inverted in forming the scale composite.)

Teacher Responsibility is a 3-item scale. Teachers reported that their success or failure in teaching students was slightly more beyond their own control than due to their own efforts and abilities. In contrast, teachers tended to disagree more than agree with statements that they sometimes feel it is a waste of time to try to do their best and that teachers are not a very powerful influence on student achievement.

Collegiality is a 4-item scale. Three of the items ask teachers to rate, on a 6-point scale with 6.0 being strongly agree, statements saying (a) they are familiar with the content and specific goals of courses taught by other teachers in their department (4.2, 1.29 where the first number is the mean and the second is the standard deviation for the total sample), (b) they make conscious efforts to coordinate the content of their courses with other teachers (4.2, 1.34), and (c) there is a great deal of cooperative effort among staff members (4.1, 1.24). The fourth item asks teachers to report how much time per month, on average, they spend meeting informally with other teachers on lesson planning, curriculum development, and other instructional matters. The total sample mean was 3.7, with a standard deviation of 1.54 on a 6-point scale that translates to, on average, less than 1 hour per month.

Teacher Satisfaction is a 3-point scale. Teachers reported that they were more likely to look forward to each working day at school than not to and that they felt satisfied with their job of teaching slightly more than half the time. They were also slightly more likely to disagree than to agree with the statement that staff members in their school generally don't have much school spirit.

Dependent Variables

Most of the dependent variables used in the regression equations have been defined already in Chapter 5. A few, however, require definition here.

Change is a 15-item scale indicating the frequency and types of changes that have occurred in the last three years in teachers' courses and at their schools that might have bearing on their instructional practices (e.g., changes in textbooks, changes in length of school day). The most frequently reported areas of change were that .59 of the teachers used different teaching methods and .55 of the teachers altered the sequence of topics. Of the total sample of teachers, .32 reported that they had revised course content to be less difficult (with a standard deviation of .47), while .23 indicated that they had revised course content to be more difficult (with a standard deviation of .42). At least for the course sections documented in the questionnaire sample, then, there was not much more tendency to decrease course content difficulty than there was to increase course content difficulty. Still, the difference favoring a decrease in difficulty over an increase in difficulty was equal to nearly one-fourth of a standard deviation and was statistically significant at the .05 level.

Teacher Demands on Students is a 7-point scale. Most of the items on this scale concern the extent to which homework is assigned and how seriously homework is taken in terms of whether it is turned in, corrected, discussed in class, or included as a part of the course grade. One item on the scale asks teacher respondents to agree or disagree with the statement that teachers in the school push students pretty hard in their academic subjects. Teachers were slightly more inclined to agree than to disagree with the statement (mean of 3.8 and a standard deviation of 1.32 on a 6-point scale, with 6.0 equalling strongly agree).

Active Learning is a 9-item scale. Teachers were asked about the extent to which students are engaged in discussion, report writing, lab or field work, observation, measurement, interpreting data, designing experiments, and other forms of active learning. Means on these items are not reported here, since better information of this type was provided in Chapter 5.

Higher Order Thinking is a 7-item scale in which teachers describe the extent to which instruction in the course being described on the questionnaire involves problem solving and applications, emphasizes indepth study, and is conceptual understanding oriented rather than skills development oriented. On average, teachers reported being somewhat more oriented toward problem solving and application than toward drill on basic skills. There is reason to suspect a positive response bias in these items; information based on daily teacher logs reported in Chapter 5 provides much better information on this matter (and not as encouraging).

Questionnaire Sample Regressions

First, regressions using policy variables and control variables to predict climate variables will be presented. Then, regressions using policy variables, control variables, and climate variables to predict classroom practices will be presented. For each regression model, reporting of results begins with a summary identifying which regression equations had significant multiple correlations and which had a significant regression coefficient for the policy variable.

Predicting Climate Variables

Table 6.1 presents the *p* values (significance levels) for each of 144 regression equations fit to the questionnaire data when using policy and control variables to predict climate variables: 16 climate variables by 3 policy variables (Group, Policy, States) by 3 samples (total, math, science). As can be seen in Table 6.1, most of the *p* values are smaller than .05, indicating that the R^2 (multiple correlation) for the regression equation is significant. Percent female in the class, class size, teacher gender, teacher years of experience, and teacher load tended to be less predictable than the other climate variables. Total sample regressions tended to be significant slightly more often than math sample or science sample regressions, due both to subject being a significant predictor and to a larger sample size.

Group as a predictor. Table 6.2 presents the regression equations for each of the school and class climate variables for which the R^2 was significant. In Table 6.2 and in all the tables of regression results that follow, standardized regression weights are presented in the first column and *p* values for each of these regression weights are presented in the second column. The R^2 is at the bottom of the table together with its *p* value and degrees of freedom.

In Table 6.2, it can be seen that the regression equation for predicting the school climate variable of Leadership is significant (p = .000 with 286 degrees of freedom) with an R^2 of .165. Significant predictors in the equation are School Ability (.20, .003, where the first number indicates the standardized regression weight and the second number indicates the *p* value associated with it), School Behavior (.22, .001), and Course Level (-.12, .044). Teachers in schools with higher student

Table 6.1

Questionnaire Sample Multiple Correlation Significance Levels:
Policy Variable and Controls Only

Dependent Variable	Group			Policy			States		
	Total	Math	Sci	Total	Math	Sci	Total	Math	Sci
Leadership	.000	.000	.005	.000*	.000*	.000*	.000*	.000	.002*
Resources	.000	.000	.000	.000*	.000	.000	.000*	.000*	.000*
Institutional Support	.000	.000	.003	.000*	.000	.000*	.000*	.074	.274
Shared Beliefs	.000	.000	.006	.000*	.000	.000*	.000	.001	.007
Teacher Control	.000	.001	.003	.000*	.000*	.000*	.000	.010	.000*
Percent Female	.093	.004*	.752	.444	.026	.829	.009*	.002*	.326
Percent White	.000*	.000	.004	.000*	.000	.001*	.000*	.000*	.000
Class Size	.023	.001*	.546	.024	.014	.307	.000*	.000*	.139
Teacher Responsibility	.000*	.000*	.001	.000	.001	.001	.000*	.001*	.001
Teacher Collegiality	.000*	.004	.022*	.000*	.003	.008*	.000*	.002	.046*
Teacher Satisfaction	.000*	.000*	.000	.000	.001	.000	.000*	.001*	.000*
Teacher Gender	.101	.557	.935	.054	.463	.659	.132	.609	.978
Teacher Ethnicity	.024*	.125	.026*	.048*	.121	.145	.003*	.104	.023*
Teacher Level of Education	.000*	.012*	.008*	.000*	.055	.041*	.000*	.068	.015*
Teacher Years of Experience	.102	.111	.175	.110	.210	.110	.002*	.011*	.048*
Load	.018*	.003*	.923	.089	.016	.836	.000*	.000*	.020*

*Indicates the policy variable was significant in the equation.

Table 6.2

Total Questionnaire Sample Regressions:
Group and Control Variables to Predict School and Class Climate Variables

Independent Variables	Leadership		Resources		Institutional Support		Shared Beliefs		Teacher Control		Percent White		Class Size	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	-.06	.262	.01	.826	.00	.976	.02	.715	-.02	.723	.11	.043	.11	.059
School Ability	.20	.003	.32	.000	.22	.001	.18	.006	.07	.260	.27	.000	.11	.119
School Behavior	.22	.001	.14	.024	.25	.000	.16	.017	.08	.218	.12	.059	.05	.496
Class Ability	.10	.076	.09	.112	.05	.401	.14	.019	.21	.000	.11	.054	-.16	.012
Subject	-.07	.201	-.05	.333	-.04	.450	-.00	.992	.20	.001	.05	.359	.06	.314
Course Level	-.12	.044	-.02	.718	-.05	.377	-.12	.044	.12	.050	.15	.009	.12	.068
R^2	.165		.195		.181		.130		.131		.210		.050	
p	.000		.000		.000		.000		.000		.000		.023	
Residual *df*	286		286		286		286		285		281		282	

ability and better student behavior are more likely to report strong leadership in their school than are teachers in schools with low student ability and poor student behavior. Further, teachers teaching course sections in basic and beginning courses tended to report school leadership as stronger than teachers teaching more advanced courses.

The R^2 for predicting Resources was also significant, with a value of .195. As was the case for Leadership, both School Ability (.32, .000) and School Behavior (.14, .024) are significant predictors.

The R^2 for Institutional Support, .181, is significant, again with significant predictors School Ability (.22, .001) and School Behavior (.25, .000).

The R^2 for Shared Beliefs, .130, is significant, with significant predictors School Ability (.18, .006), School Behavior (.16, .017), and Class Ability (.14, .019). For Shared Beliefs, then, Class Ability makes an additional independent contribution to prediction over and above that of School Ability and School Behavior.

The R^2 for Teacher Control, .131, is significant with significant predictors Class Ability (.21, .000), Subject (.20, .001), and Course Level (.12, .050). Teachers with relatively high ability classes, teachers who teach science (subject was coded Science 1, Math 0), and teachers who teach more advanced courses also report that they feel relatively more in control of what happens in their own course and in their school. The finding that science teachers report greater control than math teachers fits nicely with the finding in Chapter 3 that math is a much more regulated subject than is science.

The R^2 for Percent White students in the class, .210, is significant with significant predictors of Group (.11, .043), School Ability (.27, .000), and Course Level (.15, .009). In addition, School Behavior and Class Ability approached significance. Teachers reporting relatively high student ability for their school and whose course being described on the questionnaire was relatively advanced had a higher percent of white students in their course.

The multiple correlation for Class Size, .050, was significant, although substantially smaller than the other R^2s in Table 6.2. The only significant predictor was Class Ability (-.16, .012). Holding other variables in the equation constant, the higher the ability of the class, the smaller the class size.

In summary for Table 6.2, it can be seen that School Ability is the single most powerful predictor of school and class climate variables. The higher the ability of students in the school, the stronger the leadership, the better the instructional resources, the better the institutional support, the greater likelihood for shared beliefs among teachers, and the more teachers feel in control of practices and policies in their classroom and school. School Behavior and Class Ability also sometimes added independent contributions to the regression equations, controlling for School Ability. Again, better student behavior and higher class ability is associated with stronger leadership, better resources and support, more shared beliefs among teachers, and greater teacher control. It is also true that, holding school ability, school behavior, class ability constant, there were fewer minority students in the higher level courses. The goal of "ambitious content for all students" remains off in the distance.

Table 6.3 presents the significant regression equations for teacher climate variables using Group and Control variables as predictors and estimations based on the total questionnaire sample.

The R^2 for Teacher Responsibility, .137, is significant, with significant predictors Group (.13, .026), School Behavior (.16, .018), Class Ability (.21, .001), and Subject (-.14, .016). The positive regression coefficient for Group indicates that, holding student ability and behavior constant, teachers in California and Arizona reported, on average, accepting greater responsibility for student learning than did teachers in Florida and South Carolina, with teachers in Pennsylvania and Missouri in between. Perhaps not surprisingly, teachers in schools where students are better behaved and teaching course sections described in the questionnaire of students of higher ability tended to accept

Table 6.3

Total Questionnaire Sample Regressions:
Group and Control Variables to Predict Teacher Climate Variables

Independent Variables	Teacher Responsibility		Teacher Collegiality		Teacher Satisfaction		Teacher Ethnicity		Teacher Education		Load	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	.13	.026	.14	.018	.13	.019	.19	.002	-.26	.000	-.13	.030
School Ability	.08	.251	.06	.410	.00	.997	-.09	.222	-.09	.166	.17	.015
School Behavior	.16	.018	.15	.030	.26	.000	-.05	.478	-.00	.952	.04	.566
Class Ability	.21	.001	.16	.008	.16	.006	.01	.885	-.02	.725	-.06	.375
Subject	-.14	.016	-.08	.159	-.03	.566	.01	.879	.32	.000	.06	.339
Course Level	-.09	.124	-.02	.803	.11	.074	.04	.503	.13	.032	.04	.538
R^2	.137		.102		.156		.051		.174		.053	
p	.000		.000		.000		.024		.000		.018	
Residual *df*	286		286		286		278		286		277	

greater responsibility for student learning. Also, mathematics teachers were more likely to accept responsibility for student learning than were science teachers.

The multiple correlation for Teacher Collegiality, .102, was significant, with significant predictors Group (.14, .018), School Behavior (.15, .030), and Class Ability (.16, .008). This finding for Teacher Collegiality mirrors the finding for Teacher Responsibility and has a similar interpretation. The exception is that there is no difference between math and science in the extent to which teachers report that they work cooperatively with their colleagues.

The R^2 for Teacher Satisfaction, .156, was significant, with significant predictors Group (.13, .019), School Behavior (.26, .000), Class Ability (.16, .006). Again, these findings mirror those for teacher collegiality and teacher responsibility.

The R^2 for predicting Teacher Ethnicity, .051, is significant, with Group as a significant predictor (.19, .002). Since teacher ethnicity was coded 1 if the teacher was white and 0 if the teacher was minority, this finding means that there were more minority teachers in South Carolina and Florida and fewer minority teachers in Arizona and California, with Missouri and Pennsylvania in between.

The R^2 for Teacher Education, .174, is significant, with significant predictors Group (-.26, .000), Subject (.32, .000), and Course Level (.13, .032). Teachers in California and Arizona had weaker backgrounds in the subject they were teaching in their course section described in the questionnaire, math or science, than did teachers in South Carolina or Florida, with Pennsylvania and Missouri in between. The Subject matter effect, with its positive regression coefficient, means that science teachers had more educational background in science, on average, than did mathematics teachers in mathematics. Curiously, then, science teachers have better science backgrounds than mathematics teachers have math backgrounds, yet science teachers are less willing to accept responsibility for student learning than are mathematics teachers. The significant Course Level effect means that teachers whose course sections described in the questionnaire were more advanced were, on average, better trained in the subject they were teaching than were teachers whose course section was at a lower level. While this makes sense, it should be noted that teachers were teaching more than just the course section described in the questionnaire; the other courses they were teaching may have been at the same level or at a different level. One might infer, however, that teachers describing advanced level course sections tend to be teachers who more generally taught advanced level courses.

The R^2 for Load, .053, is significant, with significant predictors Group (-.13, .030) and School Ability (.17, .015). Holding student characteristics, subject, and course level constant, teachers in California and Arizona tend to have lighter loads than teachers in South Carolina and Florida, with teachers in Missouri and Pennsylvania in between. This finding in large part may be due to the Arizona urban high school that used significant amounts of desegregation monies to substantially reduce teaching loads so that teachers could work independently with students, interact more with parents, and have more planning time. Apparently, teachers in schools where students are of higher ability tend to have lighter loads as well. However, there is no evidence that teachers within those higher student ability schools that described higher ability classes have lighter loads.

Looking across the findings reported in Tables 6.2 and 6.3, there is definitely a pattern of results supporting the conclusion that schools serving higher ability and better behaved students and classrooms serving higher ability students have teachers who are more satisfied, are more collegial, are more likely to agree about purposes, and accept more responsibility for student learning. These schools also are perceived by teachers to have better leadership, more resources, more institutional support, and greater teacher control.

Table 6.4 presents the significant multiple regression equations for the math and science samples when Group and Control variables are used to predict climate variables. Only regression

Table 6.4

Math and Science Questionnaire Sample Regressions: Group and Control Variables to Predict Teacher and Class Climate Variables

Independent Variables	Mathematics						Science	
	Teacher Control		Percent Female		Class Size		Teacher Ethnicity	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	-.11	.159	-.23	.004	.20	.012	.24	.010
School Ability	.06	.531	.02	.869	.25	.007	-.28	.009
School Behavior	.21	.021	-.11	.221	-.07	.458	.09	.372
Class Ability	.13	.113	.07	.402	-.18	.027	-.01	.901
Course Level	.13	.095	.24	.004	.12	.129	.06	.501
R^2	.134		.110		.124		.095	
p	.001		.004		.001		.026	
Residual *df*	150		148		148		126	

equations showing results that are different from those obtained on the total sample are reported.

The R^2 for Teacher Control using the mathematics sample, .134, was significant with significant predictor School Behavior (.21, .021). In the total sample, Class Ability was a significant predictor, as was Subject, but School Behavior was not. Teachers in schools with better behaved students reported greater teacher control over school policies and classroom practices.

The Percent of Female students in the class had a significant $R^2 = .110$ for the math sample, with significant predictors Group (-.23, .004) and Course Level (.24, .004). In the total sample, the regression equation to predict Percent Female was not significant. The Group effect is hard to interpret. When ability, behavior, and course level are held constant, there tend to be fewer female students in math and science in California and Arizona than there are in Florida and South Carolina, with Missouri and Pennsylvania in between. The Course Level effect is quite surprising. In mathematics, the percentage of female students in advanced courses is greater than the percentage of female students in basic courses, holding constant ability and behavior. The unadjusted means are .44 for course level -1.0 (basic courses), .50 for course level 0.0 and .52 for course level 1.0. When looking at the means by course type, the results are even more striking. On average, .54 of the students taking Calculus were female; .54, Algebra 2; and .51, Trig/Precalculus. Basic Math had only .45 female students.

The R^2 for predicting class size from the math sample, .124, is significant, with significant predictors Group (.20, .012), School Ability (.25, .007), and Class Ability (-.18, .027). The finding of a negative relationship between Class Ability and Class Size was also found on the total sample, but in the total sample neither Group nor School Ability were significant. The interpretation of the Group effect is that class sizes are larger in California and Arizona than in South Carolina and Florida, with class size in between for Missouri and Pennsylvania. The School Ability effect, with its positive regression coefficient, means that teachers reporting relatively high student ability for their school are teaching courses described in the questionnaire with relatively large numbers of students in them. Within those schools, however, higher ability classes tend to have relatively smaller class size.

The only new finding from the regressions based on the science sample is for Teacher Ethnicity, with a significant $R^2 = .095$, with significant predictors Group (.24, .010) and School Ability (-.28, .009). The new finding is a significant regression weight for School Ability. The interpretation is that the higher the student ability for the school, the more likely the teacher in the sample was to be minority, but this was only true for science teachers. This finding is difficult to explain.

Policy as a predictor. Table 6.5 presents the significant regression equations when Policy and control variables are used to predict school and class climate variables based on the total questionnaire sample. (The Policy variable is defined in Appendix C.) Most of the findings in Table 6.5 replicate the findings in Table 6.2. The same set of climate variables was significantly predicted, with the exception of class size, which was not significantly predicted using Policy but was using Group. Further, the regression coefficients and their *p* values for control variables School Ability, School Behavior, Class Ability, Subject, and Course Level are virtually identical between the two sets of regression equations reported in Tables 6.2 and 6.5. The new findings that Table 6.5 offers, then, concern the Policy variable.

Policy is a significant predictor for each of the school and class climate variables of Leadership (.18, .001), Resources (.13, .019), Institutional Support (.19, .001), Shared Beliefs (.19, .001), Teacher Control (-.21, .000), and Percent White (-.16, .004). A greater number of recent policy initiatives and their greater perceived influence predict stronger school leadership, greater school resources, better institutional support, and stronger shared beliefs among teachers as to purpose. Because the Policy variable is primarily a function of the extent to which policies are perceived to have a positive influence, these findings go together and make sense. Strong leaders use

Table 6.5

Total Questionnaire Sample Regressions:
Policy and Control Variables to Predict School and Class Climate Variables

Independent Variables	Leadership		Resources		Institutional Support		Shared Beliefs		Teacher Control		Percent White	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Policy	.18	.001	.13	.019	.19	.001	.19	.001	-.21	.000	-.16	.004
School Ability	.17	.007	.31	.000	.20	.001	.17	.009	.09	.157	.30	.000
School Behavior	.20	.002	.13	.043	.23	.000	.13	.039	.11	.097	.13	.039
Class Ability	.12	.044	.11	.055	.07	.203	.17	.004	.18	.002	.11	.051
Subject	-.06	.300	-.04	.440	-.03	.636	.02	.772	.18	.002	.04	.479
Course Level	-.12	.036	-.02	.720	-.05	.365	-.12	.041	.12	.045	.16	.007
R^2	.193		.211		.215		.166		.174		.222	
p	.000		.000		.000		.000		.000		.000	
Residual *df*	286		286		286		286		285		281	

institutional resources and support to create shared beliefs and to bring about policy influence in a positive way. The negative regression coefficient for Policy predicting Teacher Control means that teachers who report having less control over the policies in their school and the practices in their classroom feel they are more influenced, though positively, by state and district policies. The negative regression coefficient for Policy predicting Percent of White students in the course being described in the questionnaire can be interpreted as meaning that the higher the percentage of minority students the larger state and district policy influence. This finding is consistent with the findings reported in Chapter 3. Urban districts are much more active in terms of policy formulation than are suburban and rural districts. Urban districts also have higher concentrations of minority students.

When using Policy and control variables to predict teacher climate variables based on the total questionnaire sample, only three new results were obtained (see Table 6.6). Policy is a significant predictor of Teacher Collegiality, Teacher Ethnicity, and Teacher Education. In each of those three regression equations, the regression coefficients for the control variables were similar to those reported when Group was used as the policy variable and will not be repeated here. Policy has the following regression coefficients: Teacher Collegiality (.17, .003), Teacher Ethnicity (-.17, .005), Teacher Education (.19, .001). The greater the perceived policy influence, the more likely teachers were to coordinate their efforts and to be familiar with each other's work (Teacher Collegiality). The finding for teacher ethnicity is somewhat puzzling. Minority teachers were more likely to report policy influence and activity than majority teachers. This finding may be an artifact of the earlier one that there were more minority teachers in South Carolina and Florida than in the other states, and, as has already been seen, South Carolina and Florida, with their basic skills focus, were much more active in terms of state and district curriculum policies than were the other states.

The positive regression coefficient for policy predicting Teacher Education means that teachers with better preparation in mathematics and science reported greater positive policy influence

569

Table 6.6

Total Questionnaire Sample Regressions:
Policy and Control Variables to Predict Teacher Climate Variables

Independent Variables	Teacher Collegiality		Teacher Ethnicity		Teacher Education	
	B	*p*	*B*	*p*	*B*	*p*
Policy	.17	.003	-.17	.005	.19	.001
School Ability	.05	.418	-.05	.462	-.13	.045
School Behavior	.12	.081	-.04	.548	-.01	.892
Class Ability	.21	.001	.02	.739	-.04	.475
Subject	-.07	.262	-.00	.970	.33	.000
Course Level	-.01	.875	.05	.424	.12	.055
R^2	.112		.044		.145	
p	.000		.048		.000	
Residual *df*	286		278		286	

than did teachers with weaker backgrounds in the subject they were teaching. This finding seems to run counter to the hypothesis of some that the better teachers are those most resistant to and negative about policy influence. From the previous finding of Group having a negative regression weight for predicting Teacher Education, it can be inferred that teachers in South Carolina and Florida are, on average, not only better prepared but also in states that are more policy active. This does not explain away why they would see the policy influences as largely positive.

States as predictors. Based on the total questionnaire sample, one or more states are significant predictors in an overall significant multiple regression equation using states and controls to predict the climate variables of Leadership, Institutional Support, Percent Female, Percent White, Class Size, Teacher Responsibility, Collegiality, Teacher Satisfaction, Teacher Ethnicity, Teacher Experience, Teacher Education, and Load. Table 6.7 presents the regression equations with significant state predictors for school and class climate variables. The control variables in the regression equations reported in Table 6.7 behave in the same as they did when Group was used as a predictor as reported in Table 6.2. Discussion here will focus on the regression weights for each state and their significance, since that is the new information to be found in Table 6.7.

Leadership has a significant R^2 of .221. In reference to Missouri, teachers in California report lower levels of school leadership, while teachers in South Carolina report higher levels of school leadership. Arizona, Florida, and Pennsylvania are not significantly different from Missouri. South Carolina was also the one state in the sample of six that exerted the greatest curriculum leadership from the state level but in pursuit of basic skills, while California was a close runner up for the honors of greatest state leadership but with a focus on higher order thinking and problem solving. From these results, then, there is no reason to conclude that state leadership necessarily usurps school leadership. In one of the two most active states, school leadership was significantly high, South Carolina, and in the other school leadership was significantly low, California.

Table 6.7

Total Questionnaire Sample Regressions:
States and Controls to Predict School and Class Climate Variables

Independent Variables	Leadership		Institutional Support		Percent Female		Percent White		Class Size	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Arizona	.02	.790	-.10	.195	-.05	.522	-.12	.108	.22	.007
California	-.17	.023	-.27	.000	-.25	.002	-.21	.003	.37	.000
Florida	-.10	.180	-.21	.004	-.06	.467	-.35	.000	.21	.006
Pennsylvania	.04	.591	-.14	.052	-.06	.418	-.15	.032	.09	.218
South Carolina	.13	.044	-.09	.148	.08	.244	-.08	.207	.08	.238
School Ability	.19	.004	.20	.002	-.02	.776	.23	.000	.13	.055
School Behavior	.22	.004	.27	.000	-.03	.647	.15	.019	.02	.818
Class Ability	.14	.021	.06	.315	.09	.159	.13	.024	-.20	.002
Subject	-.06	.287	-.04	.482	-.01	.867	.06	.312	.07	.279
Course Level	-.13	.030	-.05	.383	.10	.109	.15	.007	.13	.044
R^2	.221		.231		.080		.276		.117	
p	.000		.000		.009		.000		.000	
Residual *df*	282		282		277		277		278	

Institutional Support has a significant R^2, .231, with significant state predictors California (-.27, .000) and Florida (-.21, .004). While California and Florida were the only two states to have significant negative regression coefficients when contrasted to Missouri, the other states all had negative regression coefficients, too. Perhaps the high levels of institutional support for Missouri are attributable to the significant funding increases due to a desegregation court order in the Missouri urban district.

Percent Female has a significant though small R^2, .080, with significant state predictor California (-.25, .002). California high school mathematics and science classes studied had slightly fewer female students than did high school mathematics and science classes in the schools studied in the other five states.

Percent White has a significant R^2 of .276, with significant state predictors California (-.21, .003), Florida (-.35, .000), and Pennsylvania (-.15, .032). While the other two states in the regression equation did not have significant regression coefficients when contrasted to Missouri, they also had negative regression coefficients. This simply says that Missouri had higher percentages of white students taking math and science courses in the schools studied.

Class Size has a significant R^2 of .117, with significant state predictors Arizona (.22, .007), California (.37, .000), and Florida (.21, .006). In reference to Missouri, then, class sizes are significantly larger in mathematics and science for Arizona, California, and Florida, but not for Pennsylvania and South Carolina. This finding for class size is roughly consistent with the finding for institutional support.

Table 6.8 presents the regression equations having one or more states as significant predictors based on the total questionnaire sample when predicting teacher climate variables. Teacher Responsibility has a significant R^2, .165, with significant state predictors Arizona (.22, .005) and California (.16, .037). In both Arizona and California, teachers were more likely to report that they

Institutional Support has a significant R^2, .231, with significant state predictors California (-.27, .000) and Florida (-.21, .004). While California and Florida were the only two states to have significant negative regression coefficients when contrasted to Missouri, the other states all had negative regression coefficients, too. Perhaps the high levels of institutional support for Missouri are attributable to the significant funding increases due to a desegregation court order in the Missouri urban district.

Percent Female has a significant though small R^2, .080, with significant state predictor California (-.25, .002). California high school mathematics and science classes studied had slightly fewer female students than did high school mathematics and science classes in the schools studied in the other five states.

Percent White has a significant R^2 of .276, with significant state predictors California (-.21, .003), Florida (-.35, .000), and Pennsylvania (-.15, .032). While the other two states in the regression equation did not have significant regression coefficients when contrasted to Missouri, they also had negative regression coefficients. This simply says that Missouri had higher percentages of white students taking math and science courses in the schools studied.

Class Size has a significant R^2 of .117, with significant state predictors Arizona (.22, .007), California (.37, .000), and Florida (.21, .006). In reference to Missouri, then, class sizes are significantly larger in mathematics and science for Arizona, California, and Florida, but not for Pennsylvania and South Carolina. This finding for class size is roughly consistent with the finding for institutional support.

Table 6.8 presents the regression equations having one or more states as significant predictors based on the total questionnaire sample when predicting teacher climate variables. Teacher Responsibility has a significant R^2, .165, with significant state predictors Arizona (.22, .005) and California (.16, .037). In both Arizona and California, teachers were more likely to report that they

Table 6.8

Total Questionnaire Sample Regressions: States and Controls to Predict Teacher Climate Variables

Independent Variables	Teacher Responsibility		Teacher Collegiality		Teacher Satisfaction		Teacher Ethnicity		Teacher Experience		Teacher Education		Load	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Arizona	.22	.005	.22	.006	.24	.002	.10	.217	.03	.742	-.08	.304	.01	.939
California	.16	.037	.02	.758	.13	.085	-.09	.267	-.02	.765	-.18	.015	.31	.000
Florida	.07	.331	-.07	.385	.01	.881	-.22	.005	.06	.420	.10	.161	.32	.000
Pennsylvania	-.03	.692	.07	.368	.14	.053	-.03	.677	.26	.001	.00	.975	.12	.112
South Carolina	.06	.360	.09	.182	.11	.082	-.05	.483	-.03	.708	.13	.053	.14	.042
School Ability	.09	.166	.07	.301	.02	.741	-.09	.201	.10	.149	-.08	.204	.18	.008
School Behavior	.14	.038	.14	.039	.24	.000	-.04	.581	.15	.034	-.00	.943	.01	.879
Class Ability	.17	.006	.18	.005	.18	.003	.03	.643	.05	.470	-.02	.789	-.09	.171
Subject	-.13	.032	-.07	.255	-.02	.715	.02	.765	-.02	.770	.33	.000	.05	.378
Course Level	-.08	.212	-.02	.767	.10	.095	.04	.537	.01	.814	.13	.033	.04	.469
R^2	.165		.142		.184		.090		.094		.184		.161	
p	.000		.000		.000		.003		.002		.000		.000	
Residual *df*	282		282		282		274		277		282		273	

accepted some responsibility for student success or failure than were teachers in Missouri. Teachers in Florida, Pennsylvania, and South Carolina did not differ from those in Missouri. This finding is consistent with the significant Group effect. Perhaps Arizona and California's emphasis upon higher order thinking and problem solving and their lack of strong testing programs at the time of our study were more persuasive to teachers than were the approaches in the other states. To continue the argument, teachers persuaded that what is wanted is also what is right and possible may be more willing to accept responsibility.

Teacher Collegiality has a significant R^2, .142, with significant state predictor Arizona (.22, .006). This finding of greater teacher collegiality in Arizona than in Missouri may largely reflect the one urban high school in Arizona with its special programs purchased through large amounts of desegregation monies. The results for predicting Teacher Satisfaction are parallel and have largely the same explanation. The R^2 for Teacher Satisfaction is significant, .184, with significant state predictor Arizona (.24, .002).

Teacher Ethnicity has a significant but small R^2, .090, with significant state predictor Florida (-.22, .005). In comparison to Missouri, there are more minority teachers in Florida. The other states in the sample were not significantly different from Missouri.

Teacher Experience has a significant but small R^2, .094, with significant state predictor Pennsylvania (.26, .001). On average, teachers in Pennsylvania had more years of experience than did teachers in Missouri. In looking at the small and nonsignificant regression coefficients for the other states in the equation, apparently Pennsylvania had more experienced teachers than the other four states as well.

Teacher Education has a significant R^2, .184, with significant state predictor California (-.18, .015). Teachers in California had less teacher education directly relevant to teaching the course on which they were reporting in this study than did teachers in Missouri and, looking at the regression coefficients, apparently less than teachers in at least three of the other four states as well.

Load had a significant R^2, .161, with significant state predictors California (.31, .000), Florida (.32, .000), and South Carolina (.14, .042). Teachers in California and Florida had the heaviest loads of all six states in the sample and significantly heavier loads than did teachers in Missouri. Looking at the state regression coefficients in the equation, the difference between California and Florida versus Arizona is also likely to be significant. Teacher loads for Pennsylvania and South Carolina are midway between the heavy loads in California and Florida and the relatively lighter loads in Arizona and Missouri.

Table 6.9 reports significant regression equations, based on the math and science samples separately, when using states and controls to predict climate variables. Only new results from those reported in Tables 6.7 and 6.8 based on the total questionnaire sample are reported in Table 6.9. For both the math sample and the science sample, Resources had a significant state predictor; there were no significant state predictors of Resources on the total questionnaire sample. In the case of the math sample, Resources has a significant R^2, .269, with significant state predictor South Carolina (.20, .025). In the case of science, Resources has a significant R^2, .272, with significant state predictor California (.26, .015). Thus for mathematics, teachers in South Carolina reported resources more readily available than teachers in Missouri. The near zero regression coefficients for the other states suggest that South Carolina math teachers not only had more resources than Missouri math teachers but more resources than math teachers in the other four states as well. For science, teachers in California reported having more resources available than did teachers in Missouri. Again, looking at the other state regression coefficients, apparently science teachers in California had more resources than did science teachers in the other four states as well.

For the math sample, Percent Female has a significant R^2, .162, with significant state predictors Arizona (-.24, .037) and California (-.33, .003). In comparison to Missouri, then, both

Table 6.9

Math and Science Questionnaire Sample Regressions:
States and Controls to Predict Climate Variables

Independent Variables	Math								Science			
	Resources		Percent Female		Percent White		Teacher Experience		Resources		Teacher Control	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Arizona	.05	.640	-.24	.037	-.13	.179	-.08	.469	-.00	.978	.12	.294
California	-.05	.619	-.33	.003	-.22	.019	-.23	.040	.26	.015	.08	.459
Florida	-.05	.610	-.12	.236	-.33	.000	-.04	.706	.07	.477	.07	.521
Pennsylvania	-.02	.856	-.21	.051	-.15	.113	.18	.085	-.04	.716	-.23	.032
South Carolina	.20	.025	.06	.495	-.17	.044	-.07	.492	-.12	.167	-.06	.512
School Ability	.33	.000	-.02	.869	.34	.000	-.02	.854	.27	.005	.06	.522
School Behavior	.16	.066	-.10	.272	.08	.308	.24	.011	.16	.096	-.05	.574
Class Ability	.05	.526	.04	.607	.18	.022	-.01	.873	.04	.686	.19	.046
Course Level	-.09	.248	.25	.002	.17	.017	.03	.704	.08	.370	.13	.131
R^2	.269		.162		.356		.136		.272		.208	
p	.000		.002		.000		.011		.000		.000	
Residual *df*	146		144		144		144		127		126	

Arizona and California math classes had a lower percentage of female students than did math classes in Missouri (and South Carolina, judging from the South Carolina regression coefficient).

The R^2 for Percent White is also significant for the math sample, .356, with significant state predictors California (-.22, .019), Florida (-.33, .000), and South Carolina (-.17, .044). This regression equation for Percent White differs from that based on the total sample in that, for math, South Carolina had a significantly lower percentage of white students than did Missouri (which was not true in the total sample), and Pennsylvania had no significant difference in the percentage of white students in math classes in comparison to Missouri, while it did for the total sample. The findings for California and Florida are the same based on the math sample as they were when based on the total sample.

Teacher Experience has a significant R^2 based on the math sample, .136, with significant state predictor California (-.23, .040). California was not a significant predictor of teacher experience based on the total sample. Thus, in California math teachers in the participating schools had, on average, less experience than did math teachers in the Missouri participating schools.

In addition to Resources, the science sample also has a significant R^2 for Teacher Control, .208, with significant state predictor Pennsylvania (-.23, .032). There were no significant state predictors of teacher control in the total sample or in the math sample. Curiously, science teachers in Pennsylvania reported being less in control of curriculum policies in their school and less in control of their own classroom practices than did science teachers in Missouri. Pennsylvania and Missouri are the two states in the sample with the least amount of curriculum leadership at the state level of the six states in the sample, and science is less regulated than mathematics. In Missouri, even the district curriculum policies did not seem particularly strong. In Pennsylvania, both the urban and suburban districts had quite strong curriculum policies. Thus, for Pennsylvania science teachers to report that they are less in control than are teachers in Missouri is more a function of district-level policies than it is of state-level policies.

Predicting Classroom Practices

Table 6.10 presents the *p* values (significance levels) for each of the 186 regression equations fit to the questionnaire data when using policy, control, and climate variables to predict classroom practices: 14 classroom practice variables defined on both the math and the science sample by three policy variables (Group, Policy, States) by three samples (total, math, science) yield 126 regression equations, plus regression equations for each of 10 levels of Dimension A for the math sample by three policy variables, plus regression equations for each of the 8 science Dimension A levels by three policy variables for an additional 60 regression equations. Again, most of the *p* values are smaller than .05, indicating that the R^2s for the regression equations are largely significant. Classroom practices that stand out as not predictable from the policy variable plus controls plus climate variable model are text use, amount of classroom time spent learning how to solve novel problems, and depth of instruction (as defined on the questionnaire sample). In addition, the Dimension A content areas for mathematics that received little attention by teachers in any of the classes studied had little variance and were thus difficult to predict: statistics, probability, discrete mathematics. Generally, the levels of Dimension A for science were not as easily predicted as were the Level A dimensions for mathematics.

Group as a predictor. Table 6.11 presents the regression equations having significant R^2 values when using Group, control, and climate variables to predict pedagogy based on the total questionnaire sample. Of the variables describing pedagogy available for analysis in the questionnaire data set, six of the seven have significant R^2 values.

Change has a significant R^2, .172, with significant predictors Class Size (-.13, .037) and Teacher Ethnicity (-.19, .003). Change is a scale reflecting the extent to which, within the last three

Table 6.10

Questionnaire Sample Multiple Correlation Significance Levels:
Policy Variable, Controls, and Climate Variables

Dependent Variables	Group			Policy			States		
	Total	Math	Sci	Total	Math	Sci	Total	Math	Sci
Change	.001	.037	.068	.000*	.018	.031*	.000*	.001*	.057
No. Times Observed	.000*	.081	.001*	.001	.170	.003	.000*	.002*	.001
Teacher Demands	.000	.009	.012	.000	.009	.011	.000	.022	.015
Active Learning	.000*	.002	.013*	.000	.002	.036	.000	.004	.033
Computer Use	.000	.001	.083	.000	.001	.095	.000*	.000*	.197
Calculator Use	.000	.043*	.112	.000	.127	.109	.000*	.014	.090
Text Use	.703	.984	.960	.631	.948	.972	.644	.783	.936
Higher Order Thinking	.000	.001	.089	.000	.001	.170	.000	.003	.172
Memorize Facts	.000	.151	.291	.000	.269	.299	.000	.042*	.109
Routine Problems	.000	.056	.234	.000	.051	.207	.000	.028*	.369
Novel Problems	.310	.569	.552	.277	.569	.505	.399	.775	.561
Theory/Proof	.007	.008	.108	.014	.009	.132	.019	.012	.180
Breadth	.038	.858	.041*	.070	.864	.128	.040*	.887	.025*
Depth	.264	.569	.065	.178	.229	.056	.316	.424	.112
Number		.001			.000			.002	
Arithmetic		.002			.001			.003	
Measurement		.016			.042			.015*	
Algebra		.007			.008			.005*	
Geometry		.040			.041			.124	
Trigonometry		.011			.014			.035	
Statistics		.746			.769			.437	
Probability		.785			.868			.672	
PreCalculus		.001			.000*			.001	
Discrete Mathematics		.296			.207			.091	

Table 6.10 Continued

Dependent Variables	Group			Policy			States		
	Total	Math	Sci	Total	Math	Sci	Total	Math	Sci
Bio Cell			.555			.265			.671
Bio Human			.086			.217			.164
Bio Organism			.002			.000*			.006
Bio Popu			.008			.013			.033
Chemistry			.586			.626			.610
Physics			.147			.131			.295
Earth Science			.432			.493			.585
General Science			.118			.099			.090

*Indicates the policy variable was significant in the equation.

Table 6.11

Total Questionnaire Sample Regressions:
Group, Control and Climate Variables to Predict Pedagogy and Content

Independent Variables	Change		No. of Times Observed		Teacher Demands		Active Learning		Computer Use		Calculator Use	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	.08	.217	-.17	.011	.08	.227	.18	.002	-.04	.582	.13	.057
School Ability	.09	.267	-.03	.733	.07	.342	-.13	.060	-.08	.328	.06	.506
School Behavior	-.07	.354	-.05	.533	.00	.957	.01	.835	.02	.839	.07	.370
Class Ability	-.09	.184	.01	.933	-.03	.695	.03	.588	.14	.034	.21	.002
Subject	.09	.193	.20	.003	-.06	.395	.39	.000	-.05	.435	-.15	.034
Course Level	.03	.700	-.07	.288	.14	.035	-.21	.000	-.21	.002	.08	.232
Leadership	.14	.089	.14	.086	.10	.179	-.10	.159	-.01	.933	.15	.067
Resources	-.07	.366	.03	.736	-.08	.293	.03	.680	.41	.000	.18	.020
Institutional Support	.09	.257	.05	.568	.06	.434	.10	.167	-.17	.042	-.09	.274
Shared Beliefs	.08	.366	-.08	.275	.05	.489	-.10	.112	.02	.763	-.08	.252
Teacher Control	-.05	.410	-.15	.022	-.05	.435	.05	.394	-.09	.174	-.08	.198
Percent Female	-.05	.429	.06	.318	-.05	.396	-.04	.508	.05	.460	.02	.687
Percent White	-.04	.598	.06	.360	.06	.377	-.06	.303	-.06	.416	.06	.401
Class Size	-.13	.037	.03	.686	.03	.654	-.03	.588	-.04	.576	.04	.515
Teacher Gender	.08	.171	.08	.188	.06	.326	.10	.054	-.06	.362	.03	.593
Teacher Ethnicity	-.19	.003	-.10	.109	-.15	.014	-.14	.010	.10	.128	.02	.748
Teacher Education	.06	.337	-.04	.551	.03	.671	.08	.141	-.07	.312	.03	.651
Teacher Experience	-.08	.219	.02	.738	.11	.074	.02	.701	-.11	.095	-.03	.603
Teacher Load	-.05	.492	-.18	.009	.19	.005	-.00	.998	.00	.960	-.07	.291
Teacher Responsibility	.07	.344	.04	.571	.03	.671	.16	.011	-.00	.963	-.02	.727
Teacher Collegiality	.08	.304	.11	.131	.06	.378	.13	.038	.03	.721	-.13	.076
Teacher Satisfaction	.01	.916	.11	.110	.18	.011	.00	.947	-.00	.964	.04	.578
*R*²	.172		.184		.228		.364		.195		.196	
p	.001		.000		.000		.000		.000		.000	
Residual *df*	251		256		256		256		240		240	

years, teachers made changes in their course and/or there were changes in their school concerning policies that might have an influence upon the instruction they provide in their course. The Class Size effect indicates that teachers having larger course section classes were less likely to report change during the last three years. The Teacher Ethnicity effect can be interpreted to mean that minority teachers were more likely to report change during the last three years than were majority teachers. As will be seen later, this result for Teacher Ethnicity cannot be explained by confounding between the percent of minority teachers in a state and the degree of policy activity in that state. Even with States as predictors in the regression equation, the Teacher Ethnicity variable remains significant and with virtually the same size negative regression coefficient. Perhaps equally as interesting as these two significant predictors are of Change, are the large number of variables in the equation that are not significant predictors of Change. Change is no more nor no less likely in schools with high ability and well-behaved students than in schools with low ability and poorly behaved students, change is no more likely in high ability classes than in low ability classes, change is no more likely in advanced courses than in basic courses, and change is no more likely in schools with strong leadership than in schools with weak leadership (although for leadership the regression weight is positive and would be significant at the .10 level).

A variable describing the number of times a teacher is observed teaching has a significant R^2, .184, with significant predictors Group (-.17, .011), Subject (.20, .003), Teacher Control (-.15, .022), and Teacher Load (-.18, .009). The significant Group effect indicates that teachers were more likely to be observed in Florida and South Carolina than in Arizona and California, with Missouri and Pennsylvania in between. This finding reflects the relatively high emphases on teacher evaluation in South Carolina and Florida (as reported in Chapter 3). The significant Subject effect indicates that science teachers were more likely to be observed than were math teachers. The Teacher Control effect, with its negative regression coefficient, indicates that the less teachers felt in control of policies in their school and practices in their classroom, the more likely they were to be observed. Perhaps being observed, which breaks down the remoteness and isolation of teaching, makes teachers feel more responsible to outside concerns. The negative effect for Teacher Load indicates that the higher the teacher load, the less likely the teacher was to be observed. If one assumes that teachers with heavy loads are surrounded by other teachers with heavy loads, this is not surprising. Often observations are done by teachers, but teachers with heavy loads have little time for doing observations.

Teacher Demands on students is a scale indicating the extent to which teachers push students to do their best, give homework, and treat homework as a serious part of the course. Teacher Demands had a significant R^2, .228, with significant predictors Course Level (.14, .035), Teacher Ethnicity (-.15, .014), Teacher Load (.19, .005), and Teacher Satisfaction (.18, .011). The more advanced the Course Level, the higher Teacher Demands. Interestingly, again Teacher Ethnicity has a negative regression weight indicating that minority teachers placed higher demands on their students than did white teachers. Teachers who placed higher demands on their students indicated greater Satisfaction than did teachers who were less demanding. Curiously, teachers with heavy Loads were also the most likely to place greater demands upon their students. Teachers who work their students hardest are minority teachers who have heavy teaching loads. More often than not, they are teaching advanced level courses, and they are generally satisfied with their job.

Active Learning is a scale that describes the nature of classroom instruction. The more actively students are engaged in constructing their own knowledge, according to the teacher, the higher the value on the active learning scale. Active Learning has a significant R^2, .364, with significant predictors Group (.18, .002), Subject (.39, .000), Course Level (-.21, .000), Teacher Ethnicity (-.14, .010), Teacher Responsibility (.16, .011), and Teacher Collegiality (.13, .038). A positive regression weight for Group indicates that teachers in California and Arizona reported engaging their students in active learning more frequently than did teachers in South Carolina and Florida, with teachers in Missouri and Pennsylvania in between. This fits the hypothesis that led to the construction of the Group variable and is a finding consistent with the curriculum goals of the six states. California and Arizona emphasized active learning, while South Carolina and Florida emphasized mastery of basic skills. The Subject effect indicates that science instruction engaged students more actively than did math instruction. To the extent that science instruction involves lab work, this finding makes sense. Still, the NCTM Standards call for mathematics to be much more oriented toward active learning than it has been in the past. The negative regression weight for Course Level says that, holding other variables constant, advanced courses emphasized active learning less often than did basic courses. To some extent this finding may reflect teacher beliefs that in basic courses students must be active learners or their attention will wander. It is unfortunate, however, that the advanced courses didn't more actively engage their students in knowledge construction. Similar to the finding for Teacher Demands, minority teachers and teachers who accept responsibility for student outcomes were also teachers more likely to engage their students in active learning. Also teachers who reported higher levels of Teacher Collegiality were more likely to engage their students in active learning.

Apparently, Active Learning, which is very much a part of the goals of the curriculum reform of the late 1980s and 1990s is a classroom practice that can be fostered through state leadership (as indicated by the significant group effect). Further, the finding that Active Learning was more common in basic courses than advanced courses adds support to the conclusion of state leadership having an effect. Both in California and Arizona, basic courses were the special target of state curriculum reform. While Active Learning occurs more frequently in science instruction than in mathematics instruction, it is also an instructional practice more likely to be undertaken by minority teachers, teachers who accept responsibility for student outcomes, and teachers who work collaboratively with their colleagues.

Computer Use has a significant R^2, .195, as does Calculator Use, .196. To some extent, the regression equations for predicting these two variables are parallel. Class Ability is a significant predictor for Computer Use (.14, .034) and for Calculator Use (.21, .002). Resources is also a significant predictor for both Computer Use (.41, .000) and Calculator use (.18, .020). The positive effect for Resources is straightforward and obvious in its interpretation. The Class Ability positive effects mean that, holding Course level and other variables constant, computers and calculators were more frequently used in higher ability classes.

Institutional Support (-.17, .042) and Course Level (-.21, .002) are both significant predictors for Computer Use but not for Calculator Use. The negative regression weight for Course Level means that computers were used more frequently in basic courses. Generally, computers were used for drill and practice on basic skills. The negative regression weight for Institutional Support indicates that teachers reporting lower levels of institutional support made relatively greater use of computers, everything else being held constant. The interpretation of this finding is not straightforward. In contrast, Subject is a significant predictor (-.15, .034) for Calculator Use but not for Computer Use. This means that calculators were used more frequently in mathematics than they were in science.

Table 6.12 presents the regression equations with significant R^2s when using Group, control, and climate variables to predict content Dimension D based on the total questionnaire sample. Of the four levels of content Dimension D defined on the questionnaire sample, three were significantly predicted (learning to solve novel problems being the exception). In addition, Table 6.12 presents the significant regression equations for predicting the Higher Order Thinking scale and the variable describing Breadth of content coverage.

Table 6.12

Total Questionnaire Sample Regressions:
Group, Control and Climate Variables to Predict Content Dimension D

Independent Variables	Higher Order Thinking		Memorize Facts		Routine Problems		Theory/ Proof		Breadth	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	.07	.260	-.11	.096	-.02	.719	.11	.121	.12	.083
School Ability	-.03	.715	.12	.134	.06	.488	-.16	.063	.01	.887
School Behavior	.06	.434	.03	.695	-.09	.219	.13	.102	.05	.533
Class Ability	.18	.005	-.04	.514	-.20	.003	.22	.002	-.04	.527
Subject	.25	.000	.39	.000	-.20	.005	-.10	.173	-.20	.005
Course Level	.05	.432	.07	.308	-.17	.013	.16	.019	.20	.006
Leadership	-.14	.071	.10	.222	-.02	.821	.06	.462	.02	.850
Resources	-.00	.978	-.20	.011	.04	.602	-.06	.412	-.11	.155
Institutional Support	.11	.168	-.02	.834	.05	.539	-.10	.260	.06	.478
Shared Beliefs	.02	.783	.03	.658	-.05	.537	.03	.677	.07	.367
Teacher Control	-.03	.579	.08	.235	-.16	.014	.04	.516	.05	.457
Percent Female	-.12	.047	-.02	.748	.15	.016	-.12	.061	.01	.894
Percent White	-.04	.591	-.15	.045	.15	.036	-.11	.151	-.07	.343
Class Size	-.07	.245	-.00	.970	.01	.893	.04	.562	.03	.632
Teacher Gender	.03	.601	.01	.823	-.05	.378	-.06	.376	-.05	.416
Teacher Ethnicity	-.20	.001	.11	.082	.01	.842	-.08	.205	.02	.817

Table 6.12 Continued

Independent Variables	Higher Order Thinking		Memorize Facts		Routine Problems		Theory/ Proof		Breadth	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Teacher Education	.15	.015	-.08	.256	-.06	.344	.09	.181	.04	.568
Teacher Experience	-.03	.610	.04	.502	.09	.171	.03	.606	.00	.974
Teacher Load	.12	.059	-.11	.128	.04	.527	-.01	.896	-.09	.230
Teacher Responsibility	.13	.051	-.02	.767	.01	.938	-.03	.672	.05	.514
Teacher Collegiality	.01	.907	-.00	.961	.00	.972	.02	.754	.01	.934
Teacher Satisfaction	.08	.217	.04	.614	.02	.768	-.05	.537	-.17	.026
R^2	.246		.199		.209		.155		.133	
p	.000		.000		.000		.007		.038	
Residual *df*	256		237		237		237		237	

Higher Order Thinking has a significant R^2, .246, with significant predictors Class Ability (.18, .005), Subject (.25, .000), Percent Female (-.12, .047), Teacher Ethnicity (-.20, .001), and Teacher Education (.15, .015). Other things held constant, the higher class ability the greater the emphasis on Higher Order Thinking. The positive regression weight for Subject means that science teachers placed greater emphasis on Higher Order Thinking than did mathematics teachers. The negative effect for Teacher Ethnicity indicates that minority teachers placed greater emphasis on Higher Order Thinking than did white teachers, and the positive effect for Teacher Education indicates that teachers with better preparation to teach the subject they were teaching placed greater emphasis on Higher Order Thinking than did teachers less well prepared. The negative effect for Percent Female means that, in classes that emphasized Higher Order Thinking, the percent of female students was lower than in classes that did not emphasize Higher Order Thinking. Surprisingly, the Group effect was not significant, as would have been hypothesized based on the differences among states in their relative emphasis on higher order thinking. The Course Level predictor was not significant, indicating that Higher Order Thinking is no more likely to be stressed in advanced courses than it is in basic courses. The Teacher Control predictor was not significant, indicating that teachers who felt relatively in control of the policies in their school and the practices in their classroom were no more likely to emphasize Higher Order Thinking than were teachers who felt less in control, and the nonsignificant Class Size predictor indicates that Higher Order Thinking was no more likely to be stressed in small classes than in large classes. The Teacher Responsibility predictor, with its positive regression weight, approached significant ($p = .051$), suggesting that teachers who accept greater responsibility for student learning are also teachers more likely to emphasize Higher Order Thinking.

Thus, in predicting Higher Order Thinking, the absence of certain predictors as significant is as important a finding as is the significance of some of the other predictors. Group was not a significant predictor, despite knowledge of state policies suggesting that it would be. One might have expected that teaching Higher Order Thinking would be easier with smaller class sizes, and so more frequent in smaller classes, but that was not found to be the case. There are also many who believe that Higher Order Thinking is much more likely to occur in classrooms where teachers are autonomous than in classrooms where they are not, but Teacher Control was not a significant predictor. In contrast, minority teachers and teachers better prepared to teach the subject they were teaching were more likely to emphasize Higher Order Thinking in their instruction. Unfortunately, Class Ability was also a significant positive predictor of Higher Order Thinking. The curriculum reform of the 1980s and 1990s calls for ambitious content for all students, but, at least at the time of our study, better students were the ones most likely to have Higher Order Thinking emphasized in their instruction.

The emphasis on Memorize Facts has a significant R^2, .199. Subject is a significant predictor (.39, .000), indicating that science not only placed greater emphasis on higher order thinking, but it also placed greater emphasis on memorizing facts than did mathematics instruction. Resources is a significant predictor (-.20, .011), indicating that teachers in schools reporting relatively less access to necessary instructional resources were also teachers more likely to emphasize memorization of facts. To some extent in the sample, access to instructional resources was confounded with urban versus suburban and rural. Thus, this finding also implies that instruction in urban schools tended to place a greater emphasis on memorizing facts than did instruction in suburban and rural schools. Percent White is a significant predictor (-.15, .045), indicating that the higher the percentage of white students in the class, the less emphasis there was upon memorization of facts. This finding, while perhaps not unexpected, is disturbing. The finding certainly runs counter to today's curriculum reform calling for less emphasis on memorization of facts for all students.

Routine Problems has a significant R^2, .209, with significant predictors Class Ability (-.20, .003), Subject (-.20, .005), Course Level (-.17, .013), Teacher Control (-.16, .014), Percent Female

(.15, .016), Percent White (.15, .036). The higher Class Ability, the less likely there was to be emphasis on Routine Problems (which includes computation and replicating experiments). The negative effect for Subject indicates that Routine Problems were stressed more in math than in science. The negative effect for Course Level indicates that Routine Problems were stressed more in basic courses than in advanced courses. The negative effect for Teacher Control indicates that teachers who felt in control of the practices in their classroom and the policies in their school were less likely to emphasize Routine Problems in their instruction than were teachers who felt less in control. The positive regression coefficient for Percent Female indicates that the higher percentage of female students in the class, the greater the emphasis was on Routine Problems.

The extent of emphasis upon Theory/Proof in instruction has a significant R^2, .155. Class Ability is a significant predictor of Theory/Proof (.22, .002), indicating that the higher the class ability the greater the emphasis on Theory/Proof. Similarly, Course Level has a positive relationship with Theory/Proof (.16, .019). Advanced courses placed a greater emphasis on Theory/Proof than did basic courses.

Breadth has a significant R^2, .133, with significant predictors Subject (-.20, .005), Course Level (.20, .006), and Teacher Satisfaction (-.17, .026). Breadth of Instruction was greater for science than for mathematics, despite the fact that the taxonomy for describing science content had fewer topics in it than the taxonomy describing mathematics content. Advanced courses had greater breadth than basic courses, but teachers who covered more topics in their instruction, other variables being held constant, were less satisfied than teachers who focused on relatively fewer topics.

Table 6.13 presents regression equations based on the math questionnaire sample using Group, control, and climate variables to predict pedagogy. Of the seven dependent variables describing pedagogy, all but one had a significant R^2 when Group, control, and climate variables were used as predictors and based on the total questionnaire sample. Three of those six are also reported

Table 6.13

Math Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Pedagogy

Independent Variables	Change		Calculator Use		Active Learning	
	B	*p*	*B*	*p*	*B*	*p*
Group	-.01	.913	.21	.033	-.05	.593
School Ability	-.17	.163	.13	.299	-.32	.007
School Behavior	-.12	.298	.12	.313	-.05	.641
Class Ability	-.06	.550	.21	.031	.09	.285
Course Level	.02	.860	.07	.470	-.32	.000
Leadership	.12	.309	.23	.054	-.03	.785
Resources	-.10	.399	.11	.336	-.03	.801
Institutional Support	.11	.394	-.07	.610	.14	.238
Shared Beliefs	.10	.337	.03	.741	-.11	.255
Teacher Control	-.01	.885	-.09	.338	.09	.276
Percent Female	-.19	.039	.10	.264	-.12	.165
Percent White	.03	.793	-.01	.897	.09	.420
Class Size	-.11	.244	.03	.774	.12	.183
Teacher Gender	.07	.409	.08	.399	.17	.051
Teacher Ethnicity	-.19	.040	.02	.799	-.14	.127
Teacher Education	.15	.089	-.02	.852	.13	.115
Teacher Experience	-.04	.671	.01	.886	.11	.226
Teacher Load	.00	.978	-.17	.118	-.05	.593
Teacher Responsibility	.15	.157	-.08	.439	.28	.006
Teacher Collegiality	.20	.072	-.25	.029	..04	.719
Teacher Satisfaction	-.09	.370	-.00	.977	-.10	.324
R^2	.222		.229		.278	
p	.037		.043		.002	
Residual *df*	126		119		128	

in Table 6.13 because the regression equations based on the math sample differed from those based on the total sample: Change, Calculator Use, and Active Learning.

Based on the math sample, the Change R^2 is significant, .222. As was true for the total sample, Teacher Ethnicity was significant, indicating that minority math teachers were more likely to have changed their classroom practices and been in schools with changing policies during the last three years than were white mathematics teachers. Class size, which has a significant inverse relationship with Change based on the total sample, is not a significant predictor based on the math sample. Percent Female (-.19, .039) is a significant predictor of Change based on the math sample but had not been a significant predictor for total sample. Classrooms with higher percentages of female students were less likely both to have experienced change in classroom practices and to be in schools with changed policies during the last three years.

Based on the math sample, the significant predictors of Calculator Use include Class Ability, with the same positive relationship found as in the total sample regression equation. Resources, which is a significant predictor based on the total sample, is not for the math sample. The two predictors that are significant with the math sample but were not with the total sample are Group (.21, .003) and Teacher Collegiality (-.25, .029). The Group effect means that calculator use was more prevalent in California and Arizona math classrooms than it was in Florida and South Carolina math classrooms, with Missouri and Pennsylvania math classrooms somewhere in between. This finding seems consistent with the relatively heavier emphasis on the part of California and Arizona to implement a mathematics curriculum consistent with the NCTM Standards, while South Carolina and Florida were still concentrating on basic skills in mathematics. The negative regression weight for Teacher Collegiality says that, among math teachers, those making the greatest use of calculators were those least likely to be familiar with the goals and content of courses taught by other teachers in their department and who made less of an effort to coordinate and cooperate with other teachers.

While the interpretation of this result is not straightforward, it suggests that the more innovative math teachers, at least those making relatively heavier use of calculators, tended to be loners, charting the course of their own instruction independently of other math teachers around them.

The multiple regression equation to predict Active Learning using Group, control, and climate variables and based on the math sample has Course Level and Teacher Responsibility as significant predictors. For mathematics classes, as in the total sample, Active Learning is less likely in advanced courses but more likely in classrooms where teachers accept responsibility for student outcomes. Two predictors that were significant in the total sample regression equation but not in the math sample regression equation are Group and Teacher Ethnicity. The one new predictor of Active Learning based on the math sample is School Ability (-.32, .007). Active Learning was less likely in mathematics classes taught in schools with students of relatively high ability. Apparently, the emphasis on Active Learning, which is promoted by the NCTM Standards, was, at the time of our study, occurring primarily in the lower level math courses and in the schools serving lower ability students. That relatively lower ability students are receiving the benefits of math instruction that emphasize Active Learning is a positive finding, though surely higher achieving students would profit from such instruction as well.

Table 6.14 presents the significant regression equations based on the math sample when using Group, control, and climate variables to predict the content of instruction as defined by Dimension A of the taxonomy. Of the ten levels of Dimension A for mathematics, eight were predicted with significant R^2s at the .05 level of significance.

Number has a significant R^2, .321, with significant predictors Class Ability (-.22, .017), Course Level (-.38, .000) and Teacher Control (-.18, .043). Not surprisingly, then, the relatively basic content of Number and Number Relations was emphasized more in basic mathematics courses than in advanced mathematics courses and, given that, emphasized more in classes having relatively low ability students. Teachers who emphasized Number and Number Relations content in their instruction are also teachers who reported having relatively less control both over policies in their own school and practices in their own classroom. This finding is probably a function of the fact that basic mathematics courses were more heavily regulated than were advanced mathematics courses. For example, high school graduation tests in Florida and South Carolina had a relatively heavy influence over the content taught in basic courses and virtually no influence over the content taught in advanced courses.

The extent to which Arithmetic is emphasized in mathematics courses has a significant R^2, .298. The one significant predictor is Course Level (-.46, .000). Arithmetic was much less likely to be taught in advanced mathematics courses than it was in basic mathematics courses.

Measurement has a significant R^2, .256, with significant predictor Course Level (-.37, .000). Mathematics instruction is much less likely to emphasize Measurement in advanced courses than in basic courses. Similarly, for Algebra the only significant predictor is Course Level (.47, .000), with Algebra being much more likely to be taught in advanced courses than in basic courses.

Geometry, with a significant R^2 of .234, has significant predictors School Ability (-.25, .049), Percent White (.34, .004), and Teacher Ethnicity (-.34, .001), but Course Level is not a significant predictor. Geometry was less likely to be taught in schools with relatively more able students. Geometry was more likely to be taught to white students than to minority students, but Geometry was more likely to be taught by minority teachers than by white teachers.

Trigonometry, with a significant R^2, .264, has significant predictors of Course Level (.27, .005) and Teacher Load (-.24, .023). Trigonometry was more likely to be taught in advanced courses and was more likely to be taught by teachers who had a relatively lighter teaching load. This finding may reflect a tendency for math teachers teaching advanced courses to have slightly lighter loads.

Precalculus has a significant R^2, .304, with significant predictors Class Ability (.21, .021), Course Level (.35, .000), Percent White (-.35, .002) and Class Size (-.25, .006). Clearly, Precalculus was more likely the content of advanced mathematics courses than it was of basic mathematics courses. It was also more likely to be taught to classes with students of relatively high ability even after controlling for course level. Where Precalculus was taught, class size tended to be smaller than where precalculus was not taught, and, holding other predictors constant, the percentage of white students in courses where precalculus was taught was lower than in courses where precalculus was not taught. This finding is exactly the opposite of that for geometry where, holding everything else constant, the proportion of white students in courses where geometry was emphasized was relatively higher.

Table 6.14 also includes one Dimension D variable for which the significant regression equation based on the math sample differs from the significant regression equation based on the total sample. For the math sample, the R^2 for Predicting Theory/Proof is .271, with significant predictors Class Ability (.21, .024) and Teacher Education (.18, .045). The Class Ability finding is the same as for the total sample regression equation, but Teacher Education as a significant predictor is new to the math sample. Math teachers who were better trained in mathematics were more likely to include Theory/Proof as a part of the content of their instruction than were math teachers who were less well prepared in mathematics. Curiously, Course Level is not a significant predictor of Theory/Proof for the math sample, yet it is for the total sample.

Looking across the findings for the seven significant regression equations predicting mathematics Dimension A, as reported in Table 6.14, the most consistent and strongest predictor is course level. Number and Number Relations, Arithmetic, and Measurement were less likely to be taught in advanced courses, while algebra, trigonometry, and precalculus were more likely to be taught in advanced mathematics courses. Course Level was not a significant predictor for Geometry,

Table 6.14

Math Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Content

Independent Variables	Number		Arithmetic		Measurement		Algebra		Geometry		Trigonometry		Precalculus		Theory/ Proof	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	.09	.347	.06	.546	-.19	.058	-.04	.652	.03	.730	-.10	.318	.06	.555	.07	.489
School Ability	-.03	.830	-.08	.535	-.16	.194	.12	.315	-.25	.049	.17	.167	.23	.054	-.13	.294
School Behavior	.09	.425	-.01	.896	-.06	.569	-.03	.820	-.10	.407	.07	.521	.14	.201	.16	.167
Class Ability	-.22	.017	-.10	.292	.06	.503	-.05	.609	.04	.685	.18	.060	.21	.021	.21	.024
Course Level	-.38	.000	-.46	.000	-.37	.000	.47	.000	.13	.161	.27	.005	.35	.000	.17	.066
Leadership	.20	.076	.08	.469	-.17	.170	-.09	.448	-.18	.148	.04	.766	.09	.444	.11	.372
Resources	-.01	.928	.10	.355	.13	.252	-.08	.468	.04	.705	-.06	.572	-.12	.264	-.14	.218
Institutional Support	.05	.679	.00	.987	.03	.816	.15	.230	-.02	.872	-.17	.192	-.11	.360	-.16	.198
Shared Beliefs	-.10	.333	-.03	.798	-.01	.895	-.07	.466	.20	.056	.16	.118	-.06	.556	.12	.257
Teacher Control	-.18	.043	-.02	.811	.05	.621	-.00	.973	.18	.053	.01	.931	-.12	.164	.12	.180
Percent Female	.08	.343	.05	.582	-.11	.241	-.08	.357	.01	.875	-.04	.677	.05	.605	-.14	.132
Percent White	.05	.645	.01	.934	.12	.290	-.16	.149	.34	.004	.05	.661	-.35	.002	-.16	.157
Class Size	.01	.932	.02	.821	.16	.089	-.01	.943	.11	.230	-.08	.445	-.25	.006	-.04	.698
Teacher Gender	-.03	.754	.06	.484	-.01	.905	.09	.307	-.05	.562	-.01	.873	-.15	.089	-.10	.265
Teacher Ethnicity	.02	.786	.03	.705	-.00	.970	.12	.198	-.34	.001	.03	.737	.14	.129	-.09	.333

Table 6.14 Continued

Independent Variables	Number		Arithmetic		Measurement		Algebra		Geometry		Trigonometry		Precalculus		Theory/ Proof	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Teacher Education	.07	.408	-.03	.758	-.15	.094	.13	.141	-.01	.897	-.04	.632	.05	.582	.18	.045
Teacher Experience	-.14	.118	-.14	.127	.12	.211	.06	.518	-.03	.784	-.11	.237	.12	.167	.08	.391
Teacher Load	-.04	.701	.03	.773	.03	.778	.03	.786	.06	.570	-.24	.023	.08	.416	-.04	.679
Teacher Responsibility	-.05	.633	-.16	.118	.09	.402	.15	.149	-.04	.678	-.16	.124	.04	.733	.03	.758
Teacher Collegiality	-.00	.992	-.10	.372	-.07	.526	.09	.413	.02	.883	.02	.822	-.04	.732	-.03	.778
Teacher Satisfaction	-.10	.339	.09	.395	-.01	.902	.01	.929	.01	.932	-.04	.737	.10	.327	-.11	.317
R^2	.321		.298		.256		.272		.234		.264		.304		.271	
p	.001		.002		.016		.007		.040		.011		.001		.008	
Residual *df*	117		117		117		117		117		117		117		.117	

but it had a positive regression weight as well. Clearly, the content of instruction varies sharply by Course Level, even when Course Level is defined as crudely as it was in this study. This finding runs counter to the hypothesis that mathematics courses in our sample schools had been watered down to accommodate increasing numbers of relatively lower achieving students. Had that been the case, Class Ability would have been the stronger and more consistent predictor of content. Similar to the findings in Chapter 5, all evidence here points to the conclusion that basic courses have remained basic courses while intermediate and advanced courses have remained intermediate and advanced courses. Though baseline data are lacking, these results suggest that as the percentages of students taking algebra increased, in large part due to increases in high school graduation requirements, the new students received roughly the same type of algebra course as students had been receiving prior to the influx of new students.

Table 6.15 presents the science sample regression results using Group, control, and climate variables to predict pedagogy and content. Only two Dimension A content variables for science were significantly predicted. The regression equation predicting Breadth, which was significant for the total sample but not for the math sample, is significant for science and is reported.

The significant R^2 for Breadth is .266, with significant predictors Group (.26, .017), Class Ability (-.33, .004), Course Level (.30, .004), Shared Beliefs (.25, .047) and Teacher Control (.28, .008). For science courses, advanced courses have greater breadth of topic coverage than do basic courses. Holding other variables constant, lower ability classes have greater breadth of coverage than higher ability classes. The Group effect, with its positive regression coefficient, indicates that breadth of coverage in science was greater in Arizona and California than in South Carolina and Florida, with Missouri and Pennsylvania in between. Science teachers who felt they had relatively greater control over practices in their classroom and policies in their school were also science teachers who provided instruction with a broader range of coverage. Also, teachers who reported that their colleagues were

Table 6.15

Science Questionnaire Sample Regressions: Group, Control and Climate Variables to Predict Pedagogy and Content

Independent Variables	Breadth		Bio. Organism		Bio. Population	
	B	*p*	*B*	*p*	*B*	*p*
Group	.26	.017	.01	.895	.14	.169
School Ability	.11	.359	-.03	.766	-.02	.832
School Behavior	-.00	.974	-.04	.721	-.05	.645
Class Ability	-.33	.004	-.33	.003	-.42	.000
Course Level	.30	.004	.37	.000	.45	.000
Leadership	.10	.437	-.00	.991	.12	.337
Resources	-.21	.080	-.08	.451	-.07	.560
Institutional Support	-.01	.934	-.05	.683	.13	.252
Shared Beliefs	.25	.047	.08	.471	-.14	.236
Teacher Control	.28	.008	.40	.000	.00	.989
Percent Female	.04	.702	-.05	.596	-.05	.574
Percent White	-.15	.149	-.12	.223	-.03	.752
Class Size	.07	.465	.07	.438	.06	.557
Teacher Gender	-.14	.122	-.09	.295	-.03	.738
Teacher Ethnicity	.12	.242	-.13	.171	-.18	.064
Teacher Education	.05	.594	-.12	.221	-.05	.593
Teacher Experience	-.04	.694	.06	.524	-.01	.878
Teacher Load	-.07	.552	.06	.558	-.05	.636
Teacher Responsibility	.09	.373	.05	.583	.15	.143
Teacher Collegiality	-.08	.462	-.03	.752	-.14	.177
Teacher Satisfaction	-.12	.272	-.09	.397	-.10	.384
R^2	.266		.343		.307	
p	.041		.002		.008	
Residual *df*	99		99		99	

in agreement about the central mission of the school and who reported that, in their school beliefs about the importance of mathematics/science had a positive influence on science instruction, were teachers who covered a greater range of topics in their science instruction. When interpreting these results, it is useful to recognize that Science for All Americans emphasizes the value of depth of coverage over breadth of coverage as an ideal for science instruction.

The two science Dimension A variables significantly predicted by Group, control, and climate variables are Biology of Other Organisms, R^2 of .343, and Biology of Populations, R^2 of .307. For both levels of Dimension A, Class Ability is a significant negative predictor, and Course Level is a significant positive predictor. Thus, Biology of Other Organisms and Biology of Populations are content areas more likely to be taught in advanced science courses than in basic science courses and to students of relatively lower ability. Biology was coded as an intermediate level course. In addition, Teacher Control is a significant predictor of Biology of Other Organisms (.40, .000), indicating that the content area was more likely to be taught by teachers who felt in control of their classroom practices and policies in their school than by teachers who felt less in control.

Policy as a predictor. Table 6.16 presents the significant regression equations based on the total, math, and science questionnaire samples when using Policy, control, and climate variables to predict pedagogy and content. The only regression equations presented are those that are significant and that present new results from those already presented when using Group as an independent variable.

The only pedagogy or content variable having a new regression equation using Policy as a predictor was Change, with an R^2 of .189. Significant predictors are Policy (.17, .011) and Teacher Ethnicity (-.16, .010). The Teacher Ethnicity result is identical to the Teacher Ethnicity result found when Group was used as the predictor. The interpretation of Policy as a significant predictor is almost one of a tautological relationship. Policy is a scale indicating the extent to which district and

Table 6.16

Total, Math and Science Questionnaire Sample Regressions:
Policy, Control and Climate Variables to Predict Pedagogy and Content

Independent Variables	Total		Mathematics				Science	
	Change		Change		Precalculus		Biology of Organisms	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Policy	.17	.011	.15	.105	-.21	.020	.27	.008
School Ability	-.09	.258	-.16	.183	.22	.065	-.06	.581
School Behavior	-.09	.245	-.14	.210	.18	.106	-.04	.700
Class Ability	-.06	.352	-.04	.671	.19	.034	-.29	.005
Subject	.10	.130						
Course Level	.01	.853	.01	.883	.35	.000	.32	.001
Leadership	.11	.181	.10	.386	.11	.337	-.02	.890
Resources	-.08	.297	-.12	.279	-.09	.403	-.06	.559
Institutional Support	.07	.418	.11	.360	-.12	.321	-.14	.227
Shared Beliefs	.08	.297	.08	.405	-.04	.673	.07	.560
Teacher Control	-.02	.754	.02	.795	-.18	.043	.45	.000
Percent Female	-.05	.360	-.20	.020	.06	.483	-.01	.931
Percent White	-.01	.939	.04	.740	-.35	.001	-.08	.390
Class Size	-.10	.101	-.09	.292	-.26	.003	.09	.311
Teacher Gender	.06	.359	.06	.501	-.13	.127	-.14	.111
Teacher Ethnicity	-.16	.010	-.17	.065	.12	.196	-.10	.275
Teacher Education	.01	.830	.12	.162	.08	.350	-.16	.083
Teacher Experience	-.08	.221	-.03	.753	.11	.221	.03	.743
Teacher Load	-.08	.230	-.01	.927	.09	.352	.03	.791
Teacher Responsibility	.05	.446	.13	.206	.07	.511	.03	.755

Table 6.16 Continued

Independent Variables	Total		Mathematics				Science	
	Change		Change		Precalculus		Biology of Organisms	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Teacher Collegiality	.07	.344	.19	.079	-.02	.858	-.08	.405
Teacher Satisfaction	.04	.616	-.08	.419	.09	.392	-.04	.724
R^2	.189		.238		.334		.389	
p	.000		.018		.000		.000	
Residual *df*	251		126		117		99	

state policies are present and have positive influence upon math and science instruction. Change is a scale indicating the extent to which, during the last three years, policies in the school changed and/or instructional practices in the classroom changed. Not surprisingly, then, Policy has a positive regression weight for predicting Change.

For the mathematics sample, two dependent variables are significantly predicted using Policy, control, and climate variables and present new results from those when Group was used: Change and Precalculus. The only new finding for Change is that Policy is not a significant predictor for the math sample while it was for the total sample. For Precalculus, the R^2 is .334, with Policy as a significant predictor (-.21, .020). The greater the Policy activity on the part of the state and the district as perceived by the teacher, the less likely Precalculus is to be part of the content of instruction in mathematics courses. This may mean that creation of remedial courses to assist students in passing basic skills mathematics tests in order to graduate has pushed some of the more advanced mathematics courses out of the curriculum.

On the science sample, the only dependent variable with a significant R^2 and with results different from those previously reported, is Biology of Other Organisms, an R^2 = .389. Policy is a significant predictor (.27, .008), indicating that Biology of Other Organisms is content more likely to be taught by teachers reporting that they are in schools where state and district curriculum policies are especially active and positively influential. The other significant predictors of Biology of Other Organisms based on the science sample are identical to those found and already reported when Group was the predictor.

States as predictors. The significant regression equations for predicting pedagogy and content using States, control, and climate variables are reported in Tables 6.17, 6.18, 6.19, and 6.20. In all cases, the regression equations reported in these tables have only new results for the state predictors. The other control and climate variables have essentially the same regression weights as were reported for regressions using Group, control, and climate variables to predict pedagogy and content.

Table 6.17 reports the regression equations with significant state predictors of pedagogy and content based on the total questionnaire sample. Change has a significant R^2, .232, with significant state predictors Arizona (.25, .004) and South Carolina (.20, .005). Teachers in both Arizona and South Carolina reported more change in their instructional practices and in their policy environment over the course of the last three years than did teachers in Missouri. Because the change scale includes both changes in classroom practices and changes in the policy environment, it is not as direct an assessment of state and district activity as it might have been. This may help to explain why only South Carolina and Arizona were significantly different from Missouri and not California and Florida as well.

The variable reflecting the Number of Times a teacher was Observed in the last year has a significant R^2, .264, with significant state predictors Florida (.21, .015) and Pennsylvania (.38, .000). For both states, teachers reported being observed significantly more frequently than did teachers in Missouri. These results elaborate on the significant Group effect for predicting Number of Times a teacher was Observed, reported in Table 6.11. There the negative regression weight indicated that teachers in Florida and South Carolina were observed more frequently than teachers in California and Arizona, with Pennsylvania and Missouri teachers in between. Apparently, Florida more than South Carolina was the state that made the Group effect have a significant negative regression coefficient.

Computer Use has a significant R^2, .221, with significant state predictor South Carolina (.18, .013). In comparison to Missouri, South Carolina teachers reported making greater use of computers. Judging from other state regression weights, Missouri was the state where computers were used the least. Calculator Use had a significant R^2, .237, with significant state predictor California (.24, .011). This result holds for the math sample as well, but not for the science sample. The greater use of calculators in California by math teachers is consistent with the California Math Framework,

Table 6.17

Total Questionnaire Sample Regressions: States, Control and Climate Variables to Predict Pedagogy and Content

Independent Variables	Change		No. of Times Observed		Computer Use		Calculator Use	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Arizona	.25	.004	.08	.359	.04	.674	.02	.789
California	.06	.492	.02	.795	.10	.270	.24	.011
Florida	.02	.793	.21	.015	.03	.741	-.05	.613
Pennsylvania	.14	.083	.38	.000	.07	.396	.12	.131
South Carolina	.20	.005	.13	.054	.18	.013	.04	.535
School Ability	-.08	.340	.01	.910	-.08	.303	.05	.568
School Behavior	-.07	.322	-.04	.539	.00	.953	.06	.421
Class Ability	-.05	.494	.07	.276	.15	.032	.22	.002
Subject	.11	.115	.19	.004	-.05	.487	-.16	.021
Course Level	.02	.715	-.11	.078	-.21	.003	.07	.305
Leadership	.10	.232	.11	.147	-.02	.820	.15	.061
Resources	-.05	.486	.06	.437	.39	.000	.14	.070
Institutional Support	.11	.168	.07	.367	-.14	.099	-.06	.479
Shared Beliefs	.07	.346	-.09	.210	.01	.849	-.08	.253
Teacher Control	-.04	.509	-.13	.039	-.08	.206	-.07	.254
Percent Female	-.08	.172	.07	.219	.04	.509	.05	.446
Percent White	-.05	.462	.10	.177	-.06	.443	.07	.313
Class Size	-.13	.034	.03	.669	-.04	.499	.03	.598
Teacher Gender	.07	.255	.08	.189	-.07	.279	.03	.627
Teacher Ethnicity	-.22	.001	-.11	.069	.10	.119	.04	.571
Teacher Education	.05	.456	-.03	.599	-.07	.297	.04	.505
Teacher Experience	-.08	.211	-.05	.416	-.10	.133	-.05	.480
Teacher Load	-.02	.794	-.19	.006	-.02	.810	-.11	.118
Teacher Responsibility	.07	.300	.05	.412	-.00	.968	-.02	.798
Teacher Collegiality	.05	.488	.11	.125	.03	.730	-.11	.118
Teacher Satisfaction	-.02	.042	.07	.308	-.02	.772	.02	.744
R^2	.232		.264		.221		.237	
p	.000		.000		.000		.000	
Residual *df*	247		252		236		236	

which, like the NCTM Standards, calls for increased use of calculators in math instruction.

Tabie 6.18 presents regression equations for the three pedagogy dependent variables that had significant state predictors based on the math questionnaire sample and using States, control, and climate variables as predictors. The R^2 is .338 for Change, with South Carolina the only significant state predictor (.41, .000). South Carolina was perhaps the most heavily regulated state in the sample, and in South Carolina mathematics was more regulated than science. Number of Times a teacher was Observed has a significant R^2, .311, with significant state predictor Pennsylvania (.46, .000). The only change in the regression equation for Number of Times a teacher was Observed between the math sample results reported here and the total sample results reported previously is that Florida was also a significant predictor in the total sample but not the math sample. Computer Use has a significant R^2, .388, with significant state predictors California (.27, .028), Pennsylvania (.24, .029), and South Carolina (.33, .001). In contrast to the total sample regression equation, then, the math regression equation for predicting Computer Use has California and Pennsylvania, both with teachers reporting significantly more computer use than Missouri, along with South Carolina, which was also significant in the total sample. These results are not replicated on the science sample. In fact, the R^2 for predicting Computer Use is not even significant based on the science sample.

Table 6.19 reports the math sample significant regression equations for predicting Dimensions A and D using States, control, and climate variables. Again, these state results are the only new results over what has already been reported.

Measurement has a significant R^2, .292, with significant state predictor Florida (.26, .037). Math teachers placed greater emphasis on teaching measurement in Florida than they did in Missouri, holding all other variables constant. Algebra, with a significant R^2, .314, was less emphasized content in Florida than in Missouri (-.28, .016). Memorizing Facts, with a significant R^2 of .267, was more emphasized in mathematics instruction in Florida than in Missouri (.42, .001). Routine

Table 6.18

Math Questionnaire Sample Regressions: States, Control and Climate Variables to Predict Pedagogy

Independent Variables	Change		No. of Times Observed		Computer Use	
	B	*p*	*B*	*p*	*B*	*p*
Arizona	.32	.100	.11	.374	.19	.107
California	.20	.099	.02	.899	.27	.028
Florida	.10	.374	.21	.079	.13	.261
Pennsylvania	.20	.061	.46	.000	.24	.029
South Carolina	.41	.000	.18	.068	.33	.001
School Ability	-.14	.226	.03	.829	.02	.831
School Behavior	-.13	.226	.02	.855	.01	.956
Class Ability	-.03	.776	.15	.114	.18	.048
Course Level	-.02	.841	-.13	.150	-.39	.000
Leadership	.07	.520	.10	.371	.01	.907
Resources	-.18	.110	-.03	.771	.33	.003
Institutional Support	.14	.238	.15	.216	-.29	.017
Shared Beliefs	.07	.475	-.13	.168	-.02	.856
Teacher Control	-.01	.910	-.03	.722	.01	.868
Percent Female	-.20	.025	-.06	.507	.07	.415
Percent White	.06	.553	.03	.792	-.00	.965
Class Size	-.12	.159	.21	.017	-.09	.300
Teacher Gender	.01	.870	.14	.092	-.09	.288
Teacher Ethnicity	-.21	.020	.03	.768	.05	.588
Teacher Education	.15	.064	-.06	.466	-.05	.530
Teacher Experience	-.03	.747	-.02	.829	-.11	.205
Teacher Load	.02	.834	-.27	.007	-.09	.339
Teacher Responsibility	.13	.193	.09	.389	-.13	.187
Teacher Collegiality	.20	.049	.11	.304	.12	.237
Teacher Satisfaction	-.10	.307	-.07	.502	.01	.996
R^2	.338		.311		.388	
p	.001		.002		.000	
Residual *df*	122		124		115	

Table 6.19

Math Questionnaire Sample Regressions:
States, Control and Climate Variables to Predict Content Dimensions A and D

Independent Variables	Measurement		Algebra		Memorize Facts		Routine Problems	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Arizona	.03	.794	-.22	.090	.06	.677	-.14	.305
California	-.06	.657	-.21	.100	.13	.320	-.21	.123
Florida	.26	.037	-.20	.103	.42	.001	-.29	.020
Pennsylvania	.06	.612	-.28	.016	.03	.787	-.07	.551
South Carolina	-.01	.894	-.04	.676	.05	.654	.02	.855
School Ability	-.12	.343	.09	.485	-.02	.848	.05	.704
School Behavior	-.05	.666	-.04	.731	-.09	.437	-.09	.486
Class Ability	.04	.681	-.08	.436	-.01	.947	-.17	.084
Course Level	-.38	.000	.51	.000	-.17	.079	-.16	.092
Leadership	-.13	.298	-.10	.406	.13	.276	-.09	.453
Resources	.16	.161	-.11	.332	-.29	.015	.10	.403
Institutional Support	.03	.818	.15	.247	.21	.117	-.05	.721
Shared Beliefs	-.03	.802	-.06	.589	.02	.883	-.02	.870
Teacher Control	.04	.673	.01	.895	.01	.931	-.14	.126
Percent Female	-.07	.450	-.14	.138	-.04	.688	.13	.170
Percent White	.14	.216	-.21	.067	-.06	.592	.09	.441
Class Size	.15	.121	.02	.854	.09	.344	.05	.578
Teacher Gender	.00	.974	.09	.325	.07	.473	-.09	.338
Teacher Ethnicity	-.00	.967	.11	.227	.17	.072	-.08	.421
Teacher Education	-.16	.065	.13	.144	.08	.376	-.21	.019
Teacher Experience	.10	.309	.10	.303	.11	.279	.00	.965
Teacher Load	.00	.998	.06	.537	.02	.862	.13	.244
Teacher Responsibility	.05	.627	.19	.073	-.09	.421	-.03	.768
Teacher Collegiality	-.09	.432	.08	.466	.18	.115	.03	.810
Teacher Satisfaction	-.01	.910	.03	.773	.13	.226	.06	.572
R^2	.292		.314		.267		.277	
p	.015		.005		.042		.028	
Residual *df*	113		113		113		113	

Problems, with significant R^2 of .277, was less emphasized content in Florida than it was in Missouri (-.29, .020). One might have hypothesized that South Carolina and Florida would place greater emphasis on Memorizing Facts and Arizona and California less emphasis, but, to some extent, the differences between these states are controlled in the regression equation through the variable Course Level. South Carolina and Florida have more basic skills courses targeted to state graduation tests than do Arizona or California; Course Level in the equation controls for this difference.

Table 6.20 presents the State results for the science questionnaire sample when States, control, and climate variables are used to predict content and pedagogy. Only two new results are obtained. In contrast to the math sample, there are no significant state effects for predicting Number of Times Observed for science teachers. Breadth of coverage has a significant R^2, .318, based on the science sample, with significant predictor Arizona (.37, .006). Other variables held constant, Arizona science teachers provided instruction with greater Breadth of coverage of science topics than did Missouri teachers. California and South Carolina also had relatively large positive regression weights in contrast to Missouri on Breadth of coverage, but neither was significantly different from Missouri.

Log Sample Regressions

Results for the log sample regressions are reported in a parallel fashion to those for the questionnaire sample regressions. First, regressions using policy variables and control variables to predict climate variables are presented. Then, regressions using policy variables, control variables, and climate variables to predict classroom practices are presented. As described at the beginning of the chapter, the two regression models based on the log sample are different from the two regression models based on the questionnaire sample. Fewer but better control variables and fewer climate variables are used in the regression for log sample data. Control variables for the log sample are Class Ability, Course Level, and Subject. Climate variables are Percent of Female Students in the

Table 6.20

Science Questionnaire Sample Regressions:
States, Control and Climate Variables to Predict Pedagogy

Independent Variables	No. of Times Observed		Breadth	
	B	*p*	*B*	*p*
Arizona	.03	.829	.37	.006
California	-.05	.714	.21	.167
Florida	.23	.075	-.01	.917
Pennsylvania	.22	.062	.12	.339
South Carolina	.09	.381	.20	.087
School Ability	-.03	.804	.12	.325
School Behavior	-.09	.416	-.04	.748
Class Ability	-.00	.977	-.30	.009
Course Level	-.09	.358	.32	.002
Leadership	.04	.733	.07	.553
Resources	.17	.145	-.12	.352
Institutional Support	-.04	.735	.05	.686
Shared Beliefs	-.07	.534	.17	.163
Teacher Control	-.33	.001	.28	.011
Percent Female	.19	.039	.02	.875
Percent White	.17	.100	-.16	.158
Class Size	-.18	.047	.06	.569
Teacher Gender	.07	.432	-.15	.113
Teacher Ethnicity	-.21	.020	.11	.271
Teacher Education	-.07	.478	.00	.973
Teacher Experience	-.12	.216	-.02	.870
Teacher Load	-.11	.279	-.08	.503
Teacher Responsibility	.09	.357	.09	.376
Teacher Collegiality	.14	.149	-.10	.336
Teacher Satisfaction	.23	.035	-.19	.097
R^2	.369		.318	
p	.001		.025	
Residual *df*	103		95	

Class, Percent of White Students in the Class, Teacher Years of Experience, Teacher Level of Education, and Teacher Control. In the first set of regression equations, dependent variables are limited to only those climate variables to be used as controls in the second set of regression equations.

Predicting Climate Variables

Table 6.21 presents *p* values for multiple correlations using policy and control variables to predict climate variables. Each entry in the table indicates the *p* value associated with the R^2 for a regression equation. Of the 45 regressions, only eight are significant. At least in part, this reflects the much smaller sample size for log data than for questionnaire sample. Total log sample regressions had 52 degrees of freedom residual, math log sample regressions had only 20 degrees of freedom residual, and science log sample regressions had 19 degrees of freedom residual. The policy variable is a significant predictor of Teacher Control for both the total and math samples but not the science sample. Group is not a significant predictor for any of the climate variables.

Group as a predictor. Table 6.22 presents the significant total log sample regressions using Group and control variables to predict climate variables. Percent White has a significant R^2, .248, with significant predictor Class Ability (.52, .000). Holding group, subject, and course level constant, the higher the teacher reported Class Ability, the higher percentage of white students in the class.

Teacher Education also has a significant R^2, .169, with significant predictor Subject (.30, .045). This finding replicates on the log sample a finding on the questionnaire sample. Science teachers are better prepared in science, on average, than are mathematics teachers in mathematics.

Policy as a predictor. Table 6.23 presents the significant regression equations based on the total log sample when using Policy and control variables to predict climate variables. Policy was a significant predictor of only one control variable. Teacher Control has an R^2 of .189, with significant

Table 6.21

Log Sample Multiple Correlation Significance Levels: Policy Variables and Controls Only

Dependent Variables	Group			Policy		
	Total	Math	Sci	Total	Math	Sci
Teacher Control	.223	.103	.482	.025*	.006*	.287
Percent Female	.490	.629	.455	.503	.670	.448
Percent White	.005	.049	.066	.003	.036	.069
Teacher Level of Ed	.044	.991	.112	.036	.962	.200
Teacher Yrs Experience	.252	.188	.633	.259	.175	.929

*Indicates the policy variable was significant in the equation.

Table 6.22

Total Log Sample Regressions: Group and Control Variables to Predict Climate

Independent Variables	Total			
	Percent White		Teacher Education	
	B	*p*	*B*	*p*
Group	.01	.915	-.22	.090
Class Ability	.52	.000	-.08	.536
Subject	-.07	.624	.30	.045
Course Level	-.14	.344	-.03	.835
R^2	.248		.169	
p	.005		.044	
Residual *df*	52		52	

Table 6.23

Total Log Sample Regressions:
Policy and Control Variables to Predict Climate

Independent Variables	Teacher Control	
	B	*p*
Policy	-.30	.021
Class Ability	.31	.021
Subject	-.06	.697
Course Level	-.01	.970
R^2	.189	
p	.025	
Residual *df*	52	

predictors Policy (-.30, .021) and Class Ability (.31, .021). Again, these findings for the log data replicate findings reported previously for the questionnaire data. Teachers teaching higher ability classes and teachers in states, districts, and schools where there is less policy activity report feeling more in control both of policies in their own school and of practices in their own classroom.

Predicting Classroom Practices

Table 6.24 presents a summary of the regression equations using policy, climate, and control variables to predict classroom practices. There are 41 classroom practice dependent variables defined on the total sample, an additional ten levels of Dimension A defined on the math sample, and eight levels of Dimension A defined on the science sample. Of these 405 regression equations fit to the data, only 49 are significant at the .05 level. Most of the significant results are for predicting content as defined by the logs through Dimensions A, C, and D.

Group as a predictor. Table 6.25 presents the significant regression equations when Group, control, and climate variables are used to predict pedagogical practices based on the total log sample. The frequency that teachers reported doing Professional Reading has a significant R^2, .285, with significant predictors Group (.28, .033) and Teacher Education (.34, .016). Teachers in California and Arizona reported engaging in Professional Reading significantly more frequently than did teachers in South Carolina or Florida, with teachers in Pennsylvania and Missouri in between. Further, teachers better prepared to teach the subject they were teaching in the course being described in the questionnaire reported more frequent Professional Reading.

The Frequency of Testing as reported by teachers has a significant R^2, .293, with significant predictors Percent Female (-.29, .033) and Teacher Education (-.28, .043). Classrooms with higher percentages of boys are tested more frequently than classrooms with lower percentages of boys. Teachers better prepared to teach the subject of the course being described in the questionnaire tested

Table 6.24

Log Sample Multiple Correlation Significance Levels:
Policy, Control, and Climate Variables

Dependent Variable	Control and Climate					
	Group			Policy		
	Total	Math	Sci	Total	Math	Sci
Workshops	.129	.232	.155	.568	.406	.535
Planning	.297	.031*	.927	.821	.150	.991
Prof Reading	.051*	.156	.371	.178	.230	.650
No. Times Observed	.947	.415	.548	.724	.347	.403
Frequency of Test	.042	.023	.438	.073	.023	.739
Textbook	.448	.260	.468	.651	.394	.527
No Homework	.123	.227	.474	.067	.360	.157
Homework Not Corrected	.292	.344	.947	.408	.468	.906
Corrected Homework	.023	.466	.644	.022	.468	.461
Paper/Report	.327	.211	.643	.370	.290	.739
Lecture	.821	.862	.814	.839	.869	.721
Demonstration	.000	.074	.098	.000	.104	.213
Drill	.939	.999	.055	.941	.974	.032
Discussion	.419	.763	.487	.380	.939	.243
Small Groups	.021*	.273	.179	.347	.779	.295
Independent Study	.432	.477	.636	.426	.470	.632
Takes Notes	.688	.541	.719	.697	.567	.626
Student Discussion	.826	.465	.953	.635	.494	.784
Exercises	.157	.230	.683	.150	.270	.783
Student Reports	.011	.048*	.168	.010	.264	.240
Lab Work	.000	.137	.476	.000	.102	.524
Demonstration	.322	.496	.230	.102	.136	.437
Depth	.426	.535	.708	.379	.513	.623
Breadth	.190	.123	.303	.201	.032	.334

Table 6.24 Continued

Dependent Variable	Control and Climate					
	Group			Policy		
	Total	Math	Sci	Total	Math	Sci
Non-Instructional Time	.366	.023	.014	.277	.011	.019
Exposition	.104	.134	.791	.083	.131	.896
Pic. Models	.306	.583	.459	.212	.875	.221
Conc. Models	.754	.713	.013*	.727	.653	.117
Equat./Form.	.002	.264	.567	.002	.326	.584
Graph	.002	.020	.746	.003	.066	.741
Lab Work	.002	.085	.796	.002	.085	.914
Field Work	.441	–	.642	.534	–	.879
Memorize Facts	.001	.318	.099	.001	.339	.101
Understand	.047	.473	.108	.073	.451	.348
Collect Data	.009	.956	.940	.003*	.293	.958
Order/Estimate	.035	.779	.461	.035	.517	.540
Routine Procedures	.000	.527	.134	.000	.425	.338
Routine Problems	.013	.172	.769	.015	.166	.385
Inter. Data	.568	.381	.741	.575	.296	.840
Novel Problems	.433	.324	.895	.410	.165	.306
Theory/Proof	.772	.526	.969	.771	.509	.973
Number		.301			.327	
Arithmetic		.000			.000	
Measurement		.006			.006	
Algebra		.008			.010	
Geometry		.460			.368	
Trigonometry		.341			.219	
Statistics		.737			.594	
Probability		.625			.584	
Precalculus		.501			.558	
Discrete Mathematics		.072			.066	

Table 6.24 Continued

Dependent Variable	Control and Climate					
	Group			Policy		
	Total	Math	Sci	Total	Math	Sci
Bio Cell			.237			.231
Bio Human			.097			.146
Bio Organism			.052			.036
Bio Popu			.081			.076
Chemistry			.326			.152
Physics			.018			.042
Earth Science			.676			.745
General Science			.277			.264

*Indicates the policy variable was significant in the equation.

Table 6.25

Total Log Sample Regressions: Group, Control, and Climate Variables to Predict Pedagogy

Independent Variables	Professional Reading		Frequency of Testing		Corrected Homework		Demonstration		Small Groups		Student Reports		Lab	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	.28	.033	-.18	.179	-.11	.406	-.17	.119	.39	.003	-.01	.966	.03	.813
Class Ability	.14	.398	-.16	.333	-.00	.991	-.04	.777	.13	.428	.12	.473	.11	.445
Subject	.19	.222	-.31	.053	-.40	.012	-.34	.012	-.10	.513	.37	.016	.52	.006
Course Level	-.03	.858	-.06	.700	.24	.111	.38	.005	-.17	.264	-.31	.040	-.22	.088
Percent Female	-.07	.617	-.29	.033	-.19	.150	-.07	.524	.07	.615	.00	.970	-.04	.707
Percent White	.06	.666	.04	.769	.08	.600	.09	.484	.02	.906	-.24	.087	.20	.096
Teacher Education	.34	.016	-.28	.043	.02	.874	-.12	.111	-.00	.995	-.13	.342	-.10	.360
Teacher Experience	-.11	.416	.14	.303	.17	.194	-.18	.315	-.18	.168	-.02	.878	.21	.055
Teacher Control	-.13	.369	-.01	.958	-.15	.288	-.01	.946	-.33	.019	.18	.173	-.14	.216
R^2	.285		.293		.318		.508		.321		.345		.520	
p	.051		.042		.023		.000		.021		.011		.000	
Residual *df*	47		47		47		47		47		47		47	

less frequently. Subject approaches significance (-.31, .053), suggesting that testing was done more frequently in math than in science.

The frequency of Homework assigned which is then Corrected has a significant R^2 of .318, with significant predictor Subject (-.40, .012). Corrected homework is a much more frequent instructional activity in mathematics than in science.

The percentage of time teachers use Demonstration as a pedagogical strategy has a significant R^2, .508, with significant predictors Subject (-.34, .012) and Course Level (.38, .005). Demonstration is used more frequently in mathematics than in science and more frequently in advanced courses than in basic courses. Perhaps if science had used more lab work than was the case, this difference between mathematics and science might not have been found. Lab work in science was relatively infrequent, 10 percent for the log science sample.

The percentage of time instruction involved students working in Small Groups has a significant R^2, .321, with significant predictors Group (.39, .003) and Teacher Control (-.33, .019). Teachers in California and Arizona used Small Group instruction more frequently than did teachers in South Carolina and Florida, with teachers in Missouri and Pennsylvania in between. Teachers reporting relatively greater control over policies in their school and practices in their classroom made relatively less frequent use of Small Group instruction. In California, especially, small group and cooperative instruction has been promoted. Apparently, at least to some extent teachers felt coerced into using small group instruction, as reflected by the negative regression weight for teacher control.

The extent of emphasis on Students writing Reports as a part of instruction has a significant R^2, .345, with significant predictors Subject (.37, .016) and Course Level (-.31, .040). Report writing was more prominent in science instruction than in mathematics instruction, but curiously less prominent in advanced level courses than in basic courses. This inverse relationship between extent of Student Report writing and Course Level may reflect the tendency for greater instructional innovation to be occurring at the beginning course level.

The extent of Lab or field work as reported on the back of the teacher log has a significant R^2, .520, with significant predictor Subject (.52, .006). More lab work was done in science than in mathematics, consistent with the results seen in Chapter 5.

Table 6.26 presents significant regression equations when Group, control, and climate variables are used to predict content Dimensions C and D based on the total log sample. Three of the seven levels of Dimension C have significant R^2s, and six of the nine levels of Dimension D have significant R^2s.

The degree of emphasis in instruction on Equations/Formulas has a significant R^2, .403, with significant predictor Subject (-.43, .004). Not surprisingly, mathematics makes greater use of equations and formulas than does science.

The extent to which Graphs are used as a part of instruction has a significant R^2, .398, with significant predictor Course Level (.42, .005). More advanced courses make greater use of graphs than do basic courses. Interestingly, Subject was not a significant predictor for graphs, meaning that the fraction of instructional time involving graphs is no greater in mathematics than in science.

The fraction of instructional time used in Lab work as indicated on the front of the logs has a significant R^2, .404, with significant predictor Subject (.46, .002), which replicates the finding for lab work from the back of the log that lab work is more common in science.

The fraction of instructional time devoted to Memorizing Facts has a significant R^2, .443, with significant predictors Subject (.62, .000) and Percent Female (.31, .011). Memorization was a much greater part of science instruction than mathematics instruction. Memorization tended to be emphasized more in classes with higher percentages of female students than in classes with lower percentages of female students.

Table 6.26

Total Log Sample Regressions:
Group, Control, and Climate Variables to Predict Content Dimensions C and D

Independent Variables	Equations/ Formulas		Graphs		Lab		Memorize Facts		Understand		Col. Data		Order/ Estimate		Routine Procedures		Routine Problems	
	B	*p*	*B*	*p*	*B*	*P*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	-.08	.517	-.14	.253	.08	.936	.03	.798	-.15	.251	.13	.294	.09	.478	.09	.408	-.09	.473
Class Ability	.20	.203	.12	.443	.04	.787	-.05	.730	.19	.258	.07	.683	-.09	.587	-.06	.665	-.27	.097
Subject	-.43	.004	-.14	.337	.46	.002	.62	.000	.19	.230	.54	.001	.34	.032	-.64	.000	-.39	.012
Course Level	.16	.251	.42	.005	-.25	.077	.01	.927	.23	.146	-.05	.720	-.08	.589	.18	.156	-.00	.976
Percent Female	.13	.305	-.04	.745	.01	.930	.31	.011	-.33	.018	.12	.345	-.19	.150	.16	.130	-.17	.179
Percent White	-.04	.777	-.15	.257	.14	.303	.10	.431	-.16	.287	.08	.581	-.13	.361	-.03	.793	.29	.041
Teacher Education	.08	.517	.04	.766	-.19	.134	.05	.657	-.21	.124	.01	.921	.09	.504	.14	.197	-.15	.253
Teacher Experience	-.14	.269	-.22	.082	.13	.292	-.09	.471	.19	.160	.05	.682	-.26	.056	.02	.834	-.13	.310
Teacher Control	-.15	.246	.11	.377	.10	.443	.19	.135	-.18	.208	-.03	.832	.12	.398	.00	.968	.09	.523
R^2	.403		.398		.404		.443		.288		.354		.301		.546		.341	
p	.002		.002		.002		.001		.047		.009		.035		.000		.013	
Residual *df*	47		47		47		47		47		47		47		47		47	

The extent to which instruction emphasizes Understanding concepts has a significant R^2, .288, with significant predictor Percent Female (-.33, .018). Classrooms with relatively higher percentages of female students placed relatively less emphasis on conceptual understanding.

The fraction of instructional time allocated to activities involving Data Collection has a significant R^2, .354, with significant predictor Subject (.54, .001). Data collection is a much more frequent activity in science than in mathematics. If the NCTM *Curriculum Standards* become influential, this difference between mathematics and science may disappear. Clearly at the time of our study, what little data collection activity took place took place primarily in science courses. The one notable exception as seen in Chapter 5 was California's Math A.

The fraction of instructional time devoted to Ordering, comparing, Estimating, and approximating has a significant R^2, .301, with significant predictor Subject (.34, .032). More Order/Estimate instruction takes place in science than in mathematics. The regression coefficient for Teacher Experience approached significance (-.26, .056). Teachers better prepared to teach the course being described in the questionnaire, be it science or mathematics, placed less emphasis on instruction involving ordering, comparing, estimating, and approximating, despite the fact that NCTM Standards call for increased attention to students learning to estimate and approximate.

Routine Procedures (performing procedures: execute algorithms/routine procedures, including factoring, classify) has a significant R^2, .546, with significant predictor Subject (-.64, .000). A greater emphasis was placed upon performing Routine Procedures, including computation, in mathematics classes than in science classes. Solving Routine Problems (replicating experiments/ replicating proofs) has a significant R^2 .341, with significant predictors Subject (-.39, .012) and Percent White (.29, .041). Mathematics teachers placed greater emphasis on students solving Routine Problems, including story problems, than did science teachers. There was a tendency for instruction to emphasize Routine Problems in classrooms with higher percentages of white students than in classrooms with lower percentages of white students.

Table 6.27 presents the results for significant regression equations based on the math and science log samples when Group, control, and climate variables are used to predict pedagogy and content. For the mathematics sample, regression equations were significant for predicting frequency of teachers engaging in Planning with colleagues, emphasis on Student Report writing, the fraction of class time allocated to Noninstructional activities, and the degree of emphasis upon Arithmetic, Measurement, and Algebra.

The R^2 for Teacher Planning with Colleagues, .526, is significant, with significant predictors Group (.38, .027), Class Ability (.64, .014), and Percent Female (-.45, .016). Teachers in Arizona and California reported planning with colleagues more frequently than did teachers in Florida and South Carolina, with teachers in Missouri and Pennsylvania in between. To some extent, this result may be influenced by the Arizona urban high school, with the sharply reduced teaching load. Teachers teaching courses described in the questionnaire with higher ability students reported planning with colleagues more frequently, and teachers teaching classes with higher percentages of males reported planning with colleagues more frequently.

Based on the math sample alone, the regression equation for predicting the frequency of Student Report writing is quite different from the regression equation based on the total log sample. The significant R^2, .497, has significant predictors Group (.44, .015), Class Ability (.55, .036) and Course Level (-.44, .020). Math teachers in California and Arizona engaged students in Report Writing more frequently than did teachers in South Carolina or Florida, with teachers in Pennsylvania and Missouri in between. Math teachers with higher ability classes engaged students more frequently in Student Report writing. Math teachers teaching basic courses engaged students more frequently in Student Report writing than did teachers teaching advanced courses in mathematics. This finding on

Table 6.27

Math and Science Log Sample Regressions:
Group, Control and Climate Variables to Predict Pedagogy and Content

Independent Variables	Mathematics											
	Planning		Student Reports		Non-instructional Time		Arithmetic		Measurement		Algebra	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Group	.38	.027	.44	.015	-.16	.320	.18	.099	.03	.842	-.14	.340
Class Ability	.64	.014	.55	.036	.16	.507	.07	.652	-.10	.641	-.12	.585
Course Level	-.14	.418	-.44	.020	-.38	.033	-.83	.000	-.68	.000	.74	.000
Percent Female	-.45	.016	-.20	.275	.05	.784	-.24	.048	-.01	.971	-.04	.807
Percent White	-.21	.30	-.19	.365	-.11	.574	-.08	.552	-.12	.491	.01	.975
Teacher Education	-.18	.267	-.06	.706	.280	.087	-.12	.259	-.00	.984	.15	.322
Teacher Experience	.33	.093	.24	.222	-.51	.012	.04	.746	.14	.407	-.05	.787
Teacher Control	-.32	.142	.08	.720	-.20	.328	-.20	.164	.23	.227	-.29	.139
R^2	.526		.497		.543		.793		.615		.597	
p	.031		.048		.023		.000		.006		.008	
Residual *df*	20		20		20		20		20		20	

(Continued)

Table 6.27 Continued

Independent Variables	Science					
	Non-instructional Time		Concrete Models		Physics	
	B	*p*	*B*	*p*	*B*	*p*
Group	-.16	.348	.45	.017	-.31	.086
Class Ability	-.44	.031	.43	.035	-.02	.902
Course Level	-.01	.954	-.19	.281	-.65	.002
Percent Female	.16	.345	-.10	.519	.13	.445
Percent White	.18	.321	-.27	.147	.05	.775
Teacher Education	-.63	.002	.29	.112	-.28	.126
Teacher Experience	-.06	.687	-.57	.002	-.18	.262
Teacher Control	.60	.001	-.15	.356	.38	.029
R^2	.589		.593		.575	
p	.014		.013		.018	
Residual *df*	19		19		19	

Course Level may reflect a greater degree of experimentation with basic courses and the recent emphasis on student knowledge construction and developing communication skills.

The fraction of class time devoted to Noninstructional activities has a significant R^2, .543, with significant predictors Course Level (-.38, .033) and Teacher Experience (-.51, .012). In mathematics courses, then, a greater fraction of class time is allocated to Noninstructional activities in basic courses than in advanced courses, holding constant Class Ability. Perhaps not surprisingly math advanced courses are more serious of purpose than are basic courses. Still, the motivation to extend the school day and school year is based largely on the unacceptable levels of achievement of students, especially students struggling in school. As seen in Chapter 5, the amount of noninstructional time when aggregated to the full school year represents weeks and sometimes months of lost instructional time. The negative regression coefficient for Teacher Experience says that the fraction of noninstructional time is lower for experienced teachers than for less experienced teachers. This result runs contrary to hypotheses that the most senior teachers are more likely to be burned out and less serious of academic purposes.

Dimension A levels Arithmetic, Measurement, and Algebra all have significant and substantial R^2s. In each case Course Level is the single most powerful predictor. Regression weights for Course Level are: Arithmetic (-.83, .000), Measurement (-.68, .000), Algebra (.74, .000). As for the questionnaire sample, basic courses put a much heavier emphasis on Arithmetic and Measurement, and advanced courses put a much heavier emphasis upon Algebra. These findings run counter to the watering-down hypothesis, especially when it is taken into account that Course Level is a strong predictor of content even when Class Ability is held constant.

For the science sample, three classroom practice variables are significantly predicted, Noninstructional Time, with an R^2 of .589, the extent to which instruction involves use of Concrete Models, with an R^2 of .593, and the extent to which instruction covers the topics of Physics, with an

R^2 of .575. The significant predictors for noninstructional time are Class Ability (-.44, .031), Teacher Education (-.63, .002), and Teacher Control (.60, .001). For science classes, a greater fraction of class time was devoted to Noninstructional activities in low ability classes than in high ability classes. In math it was Course Level rather than Class Ability that had the significant negative regression coefficient for predicting Noninstructional time. Either way, it might be argued that the students who are most in need of instruction are getting the least instruction. Teachers better prepared to teach science had a lower fraction of class time devoted to Noninstructional activities. Teachers who reported being in greater Control of policies in their school and practices in their classroom curiously report greater fractions of class time devoted to Noninstructional activity.

The significant predictors for degree of instructional emphasis on Concrete Models are Group (.45, .017), Class Ability (.43, .035), and Teacher Experience (-.57, .002). Teachers in Arizona and California made greater use of Concrete Models in their instruction than did teachers in Florida or South Carolina, with teachers in Missouri and Pennsylvania in between. This is consistent with state instructional leadership. Teachers with higher ability classes made greater use of concrete models than teachers with lower ability classes. While this may not be a surprising finding, it does not make much pedagogical sense. Students who have the most difficulty with school are the students most in need of good instruction. Providing several different representations of concepts to be learned has been shown to benefit student learning and pay the greatest dividends for otherwise low achieving students. The negative regression coefficient for Teacher Experience indicates that newer teachers are more likely to make use of concrete models in their instruction than are more senior teachers. Perhaps newer teachers, having more recently experienced preservice teacher education, are more in tune with the cognitive science basis behind the curriculum reform of the 1980s and 1990s.

The extent to which Physics is emphasized content in science instruction has a significant R^2, .575, with significant predictors Course Level (-.65, .002) and Teacher Control (.38, .029). The inverse relationship between Course Level and emphasis on physics has a straightforward interpretation. In the log sample, there were eight basic physical science courses that placed considerable emphasis on physics and no advanced level physics courses. The significant positive regression weight for Teacher Control indicates that science teachers who felt relatively more in control of the policies in their school and practices in their classroom placed greater emphasis on Physics content than did teachers who felt less in control. The meaning of this result is not clear; in the six states studied, science was a largely unregulated subject. This makes it difficult to conceptualize the variance among science teachers on the Teacher Control variable.

Policy as a predictor. Table 6.28 presents the significant regression equations when Policy, control, and climate variables are used to predict classroom practices based on the total, math, and science log samples. Again, only regression equations are presented that are significant and that add new findings to those already reported for the Group predictor.

For the total log sample, the only new finding for Policy is in the regression equation predicting instructional emphasis on Collecting Data, with an R^2 of .393. Significant predictors of emphasis on Collecting Data are Policy (-.27, .046) and Subject (.50, .001). The Subject effect is virtually identical to that found when Group was the predictor. The negative effect for Policy means that Data Collection was a relatively less frequent part of instruction for teachers reporting that their state and district had curriculum policies with positive effects on instruction. Because the most policy active districts and states in the sample were also the districts and states with the greatest emphasis on minimum competencies and basic skills, this finding makes sense. Presumably, had states and districts promoting higher order thinking and problem solving had a broader, more powerful, and more recent set of curriculum policies to promote their agenda, Policy might have had a significant positive regression coefficient.

Table 6.28

Total, Math and Science Log Sample Regressions:
Policy, Control and Climate Variables to Predict Content

Independent Variables	Total		Mathematics		Science			
	Collect Data		Breadth		Bio. Organism		Drill	
	B	*p*	*B*	*p*	*B*	*p*	*B*	*p*
Policy	-.27	.046	-.39	.057	.20	.293	.25	.196
Class Ability	.15	.356	.45	.103	.19	.365	-.04	.840
Subject	.50	.001						
Course Level	-.05	.713	-.43	.024	.46	.021	.03	.890
Percent Female	.04	.774	.09	.631	-.00	.988	.05	.769
Percent White	.04	.745	-.15	.446	-.08	.685	-.09	.629
Teacher Education	.07	.607	.14	.384	.05	.797	-.04	.830
Teacher Experience	.07	.558	-.10	.613	.48	.009	-.61	.002
Teacher Control	-.15	.295	.21	.403	.06	.732	-.24	.187
R^2	.393		.524		.533		.541	
p	.003		.032		.036		.032	
Residual *df*	47		20		19		19	

In the mathematics sample, Breadth of instruction has a significant R^2, .524, with significant predictor Course Level (-.43, .024). In mathematics, then, the more basic courses were also the courses that covered the greatest range of topics. This finding runs counter to the 1980s and 1990s curriculum reform that calls for sacrificing breadth of coverage to achieve the depth of understanding that makes knowledge useful.

For the science log sample and when using Policy, control, and climate variables as predictors, emphasis in instruction on Biology of other Organisms has a significant R^2, .533, as does relative emphasis on Recitation/Drill, with an R^2 of .541. The significant predictors for emphasis of Biology of other Organisms are Course Level (.46, .021) and Teacher Experience (.48, .009). The Course Level finding reflects that biology was a mid-level course rather than a basic course. The Teacher Experience finding suggests that experienced teachers are more likely to teach biology than to teach the basic science courses of general science, physical science, earth science, and life science. The significant predictor for Recitation/Drill is Teacher Experience (-.61, .002). Less experienced teachers in science were much more likely to use Recitation/Drill as an instructional strategy than were more experienced teachers. This completes a rather mixed picture of whether more or less experienced teachers provided better quality instruction. On the one hand, most would believe that use of recitation and drill is not a powerful pedagogical strategy and should be used sparingly. Instead, newer science teachers made relatively greater use of recitation and drill. On the other hand, it was the newer science teachers who made relatively greater use of concrete models as a part of their instructional repertoire.

Chapter 7

SUMMARY AND CONCLUSIONS

Reform Up Close is a study of high school mathematics and science in six states, 12 districts, and 18 schools. Data were collected in 1990 and 1991, well after the first round of state and district standard setting following *A Nation At Risk* (1983). The study represents a comprehensive effort to document, on the one hand, state, district, and school policies and practices concerning mathematics and science instruction and, on the other hand, the enacted curriculum as provided by teachers and experienced by students.

The motivations for the study were several. First and foremost, the study sought to determine whether math and science curricula were being compromised by increased enrollments due to increased high school graduation requirements. An early hypothesis was that increased high school graduation requirements would result in increased dropouts. When that did not occur, it was hypothesized that courses would be compromised to accommodate increased numbers of weaker students. In addition to this primary motivation, the study sought to describe the nature of state, district, and school curriculum policymaking as it applies to high school science and mathematics. Because the study required detailed descriptions of content and pedagogical practices as they occurred in high school mathematics and science courses across the country, the study served yet a third purpose of providing baseline data against which the ambitions of the late 1980s curriculum reforms could be judged. A fourth purpose of the study was to determine the relationship between curriculum policy characteristics and classroom practice. While it was not a motivating factor for the study, there is yet a fifth aspect of the work of major significance. To describe the enacted curriculum, methodological advances were necessary in procedures for describing opportunity to learn. As interest in school process indicators has increased in recent years, efforts to define and measure opportunity to learn have also increased. The methods developed here appear quite promising.

Design and Sample

The design of the study was straightforward. Six states were selected based on their ability to provide contrasts in curriculum policy formulation. California and Arizona represented two states already at work on trying to reform curriculum to place greater emphasis on higher order thinking, problem solving, and reasoning. In contrast, Florida and South Carolina represented two states with fairly comprehensive curriculum control strategies aimed at guaranteeing basic skills. Missouri and Pennsylvania represented two states between these extremes, states relatively inactive in terms of providing curriculum leadership. In each state, two districts were selected, one large urban and one smaller suburban/rural. The district contrast allowed investigation of curriculum policymaking in both large- and small-district bureaucracies. In the urban districts, two high schools were studied so that within-district school variability could be determined. In the smaller district, only one high school was studied; in some of the districts, only one high school existed. Throughout, the focus was on schools serving high concentrations of low achieving students from poor families.

For describing the enacted curriculum, teacher's daily logs of instruction were obtained from two math and two science course sections in each high school. Courses were selected because of large enrollment increases since state increases in high school graduation requirements; all six states had increased those requirements during the period just preceding the study. The obtained sample of log data represented 62 course sections with a median of 165 instructional days. In addition, questionnaire survey procedures were used with all math and science teachers in the 18 schools studied. Classroom observations and teacher interviews completed the data collection strategies for describing the enacted curriculum. Interviews were conducted at the school, district, and state levels to characterize curriculum policies and their perceived effects.

The data set for analysis was large and complex, consisting of 18 state-level interviews, 44 district-level interviews, 76 school-level interviews, 81 teacher interviews, 116 classroom observations, 312 teacher questionnaires, and teacher logs on 62 course sections.

The sample of students in classrooms for which log data were available was 30 percent white, 39 percent black, 25 percent Hispanic, and 7 percent Asian. From the questionnaire data, teachers reported students in the selected classes as well below the national average in ability and reading achievement. They also reported students in those classes as expending less effort than teachers had expected. Student behavior was seen as a significant problem, with absenteeism leading the list of problems by a wide margin and tardiness and class cutting next most significant.

The teacher sample was much more heavily white (77 percent), with 15 percent black, 6 percent Hispanic, and 2 percent Asian. This characterization of the teacher sample, however, varied substantially by state from Arizona, with a high of 92 percent white teachers, to Florida, with only 57 percent white teachers. The teachers varied in their years of experience (on average 13.9 years) and in their qualifications to teach the courses they were teaching. (Twelve percent were not certified to teach the science or math course for which we were collecting information.)

Methodological Advances in Defining and Measuring Opportunity to Learn

Increasingly, opportunity to learn is being seen as an important variable in education research and evaluation. The origins of the concept of opportunity to learn may be in John Carroll's model of school learning (1963). Probably IEA studies of education achievement have done the most to popularize the use of opportunity to learn as an explanation for student achievement (McKnight et al., 1987). When basic skills reforms turned to high stakes testing as an instrument of curriculum upgrading, opportunity to learn was at the heart of court cases on issues of fairness. For example in the *Debra P. versus Turlington* court decision (1981), a phase-in period was required before Florida could use its basic skills test as a requirement for high school graduation. During the phase-in period, schools were to make any adjustments necessary so that all students had the opportunity to learn material tested. In 1992, a concept of school delivery standards was introduced, again as an equity assurance (NCEST, 1992). With the emphasis on curriculum reform, higher standards, and high stakes testing, school delivery standards were to serve as a mechanism for protecting students from being held accountable if their school was weak. Again, opportunity to learn was seen as the essential ingredient in school delivery standards. In fact, one year later the concept of school delivery standards had evolved into opportunity to learn standards (Porter, 1993). In looking beyond course titles to see what effects curriculum standard-setting initiatives were having on high school mathematics and science instruction, this Reform Up Close study also required measures of opportunity to learn.

At present, there is no accepted definition of opportunity to learn. At a minimum, opportunity to learn implies that students have been exposed to certain content, but even this minimum definition has two problems. One is how to define content, and the other is what constitutes exposure. Increasingly, attempts to define opportunity to learn have turned toward a combination of access to content and acceptable pedagogy.

Any measure of opportunity to learn must satisfy several requirements. First, the measure must allow comparisons among types of students receiving instruction so that issues of equity can be addressed. Are black students receiving the same opportunity to learn as white students? The measure of opportunity to learn must allow for comparisons among educational programs, schools, districts, and perhaps even states. These comparisons are needed for purposes of diagnosing the adequacy and quality of instructional delivery. Opportunity to learn measures must also allow for comparisons against curriculum standards, such as the NCTM *Standards* in mathematics. These comparisons against standards are necessary so that opportunity to learn can be used to judge progress of reform implementation.

If opportunity to learn is to be used for policy purposes and court cases, the measures must provide information in a parsimonious fashion, ideally yielding quantitative data. Obviously, the measures must be valid. If they are to be used widely, they also must be efficient.

Procedures for defining and measuring opportunity to learn in high school mathematics and science were described in Chapter 2 and the results of their use provided in Chapters 5 and 6. A four-dimensional taxonomy in each subject matter area created a language that teachers could use for describing the content of their instruction. The first two dimensions of the taxonomy characterize what many might call the topics of mathematics and science. Dimension A describes fairly large domains of content, such as algebra in mathematics and chemistry in science. Dimension B, nested within Dimension A, provides a more detailed breakdown of each of the Dimension A domains. Examples of Dimension B are linear equations in algebra and equilibrium in chemistry. In mathematics there are ten levels of Dimension A, and in science there are eight levels of Dimension A. In each subject there are up to ten levels of Dimension B for each level of Dimension A. Dimension C of the taxonomy describes modes of instruction, for example, lab work, graphical work, and verbal and written exposition. Dimension D defines the intended learner outcomes, for example, understand concepts, interpret data, recognize patterns.

The dimensions and levels of the two taxonomies were based on curriculum reform documents and the suggestions of subject matter experts.

A topic is defined by the intersection of the four taxonomy dimensions. In mathematics there are approximately 6,000 possible topics, and in science, over 4,000 possible topics. Opportunity to learn can be defined at the topic level, at the marginal level, or even through pairwise combinations of taxonomy dimensions. The languages of the taxonomies allow opportunity to learn to be described in terms of access to algebra, or access to lab work, or access to instruction on how to interpret data (e.g., the marginals of the four dimensions of the taxonomy).

The taxonomy languages provide definitions of opportunity to learn that draw on both content and pedagogical considerations. To measure opportunity to learn using the languages, two approaches were taken. A procedure of logs was developed through which teachers gave daily accounts of their instruction. A manual was written for use in training teachers in the taxonomy language and the log form procedures. Daily logs were kept for one section of a course over a full school year. Logs were completed daily and sent weekly to Madison, Wisconsin, for editing and entry into a data bank. A questionnaire was also used for measuring opportunity to learn, again drawing on the taxonomy languages. Using questionnaires, teachers described opportunity to learn provided by their instruction for a semester, sometimes retrospectively and sometimes prospectively.

Questionnaires were validated against daily logs, and daily logs were validated against independent classroom observations. In both cases, the results were very encouraging, though clearly the highest quality measure of opportunity to learn came from daily logs.

The taxonomy languages, the daily log measurement procedure, and the questionnaire measurement procedure represent significant advances in defining and measuring opportunity to learn. With some modifications, the questionnaire approach should provide a method for measuring opportunity to learn that might be used in a system of school process indicators (Porter, 1991).

The Curriculum Policy Landscape

Chapters 2, 3, and 6 contain a great deal of detailed information about the curriculum policy setting at the beginning of the 1990s. From these data, several themes emerge.

What Did Curriculum Policy Look Like in 1990?

Our Reform Up Close study of high school mathematics and science took place at a time of great transition. The basic skills curriculum control policies of the 1970s were giving way to the early initiatives of a new curriculum reform designed to provide instruction in higher order thinking and problem solving for all students. Professional associations had begun the curriculum standard setting process, with the National Council of Teachers of Mathematics in the lead. Some states were ahead of the professional associations; within our sample California was the best example. But not all states were in the same place in the transition from basic skills to ambitious content for all students. In our sample, Missouri and Pennsylvania, relatively inactive states in the prior basic skills movement, had not yet picked up the mantle for the new reform either. A reasonable prediction is that these states will remain relatively quiet on matters of curriculum, athough since the time of our data collection, Pennsylvania has received considerable attention for its beginning efforts in outcome-based education. South Carolina and Florida, two excellent examples of states providing strong leadership in guaranteeing basic skills for all students, found themselves caught in a bind. Just when they had in place well-functioning basic skills curriculum policies, the nation decided to move toward a new goal of ambitious content for all students. At the time of our study, these states were beginning to talk about changing their systems, but with their heavy reliance on basic skills mandates, much work needed to be undone. Change will not be easy for these two states. Their basic skills initiatives had improved the quality of instruction for the weakest students and were showing clear benefits widely recognized by teachers.

Because states, districts, and schools were in a transition period, moving from one curriculum reform to another, 1990 was a time of great opportunity for inconsistency among policies. Curriculum frameworks appeared to be the lead policy instrument of choice for states and districts moving toward the goal of ambitious content for all students. California and Arizona both had curriculum frameworks consistent with this goal. At the time of our study, however, neither state had tests consistent with the goal. Arizona continued to test using basic skills oriented instruments. California was just turning away from its traditional tests and has, since our study, initiated an ambitious new performance assessment program consistent with an emphasis on higher order thinking, problem solving and reasoning in all the academic subjects, at all levels of schooling, and for all students.

We detected a transition in the style of curriculum policy formulation, as well. As the goal shifted from one of guaranteeing minimum basic skills to one of higher order thinking and problem solving, the style of policy leadership appeared to be shifting from one of controls and mandates to one of persuasion. California's curriculum framework is not required, nor are there clear rewards and sanctions attached to California's new assessment program, at least at the state level. Increasingly, teachers are being involved in significant ways in policy formulation and development. Teachers have always had an important role in textbook adoption, and in some cases teachers have had significant involvement in developing curriculum frameworks and guides. But in our states and districts in 1990-1991, there tended to be significant teacher involvement in virtually every policy initiative at every level of the formal school hierarchy. This movement in curriculum leadership, away from control and toward persuasion, is likely a very positive development. Curriculum policies in which teachers have had significant involvement are likely to be authoritative and convincing. Their effects are likely to be consistent with the intended effects, and longer lasting (e.g., Porter, 1989).

Not only was 1990 a period of transition in curriculum policy formulation, it was also a time in which states, districts, and schools differed sharply one from another in the nature and extent of curriculum policy leadership they offered. There were some patterns, however. Districts tended to follow state leadership, especially the large urban districts. In California, where state frameworks emphasized ambitious content for all students, the urban district was trying to eliminate tracking in its schools. The same was true for Arizona and the large urban district there. In South Carolina, state basic skills and testing initiatives were strengthened substantially by district tests that were designed for selected courses and that students were required to pass to receive course credit. Florida's curriculum control basic skills initiatives were enhanced substantially by the Florida urban district's policy to give monetary bonuses to schools and teachers exhibiting good test performance. In contrast, our rural districts, with their substantially smaller bureaucracies but not necessarily less pressing problems, tended to take a minimalist approach to curriculum leadership. In some cases, these rural districts were so small that distinguishing between district and high school policies was impossible.

The two districts in Pennsylvania represent an exception to the tendency for districts to follow state leadership. In Pennsylvania, there was essentially no significant curriculum leadership from the state level. Nevertheless, both the large urban district and the smaller urban district studied in that state had substantial curriculum policy initiatives. Both Pennsylvania districts had developed course level tests that were to be used for midterm and final examinations in high school math and science classes. These course testing policies didn't quite have the same clout as in the South Carolina urban district, where students were required to pass the district test to get course credit. Still, they were used as a part of course grades. In the smaller urban district in Pennsylvania, strong district testing policies were accompanied by strong pressure for high schools to eliminate basic courses and to require all students to take at least beginning college preparatory courses in both mathematics and science.

Curriculum control policies emanating from state and district levels do not appear to standardize practice at the school level in the way that might be hypothesized. In fact, state and district curriculum policies appear to have the opposite effect, causing school and classroom practice to become more variable than it otherwise might have been. This surprising finding has at least two explanations. First, state and district curriculum policies are often not very prescriptive. They leave large zones for interpretation. Not surprisingly, interpretation is exactly what happens at the local level. Some schools take a state or district curriculum policy more seriously than do other schools. Some schools use state and district policies as excuses to add initiatives, and others do not. A second explanation of the increased variability concerns the intention of a curriculum policy. The emerging policies to promote higher order thinking and problem solving call for school practice substantially different than was the norm at the time of our study. Bringing about massive shifts in practice as, for example, envisioned by the California curriculum frameworks is not easy. Just getting across the message about what is wanted is a challenge, and, of course, teachers understand that message in their own individualistic ways. Even more important, however, schools and teachers differ substantially one from another in their ability to deliver on the much more difficult and challenging curriculum of ambitious content for all students. Thus, local interpretation, local initiative, and local capacity are all stimulated by state and district curriculum policies. This stimulation leads to greater diversity in classroom practice.

Many state and district curriculum policies are quite weak when judged in terms of their prescriptiveness, the degree to which collectively they are consistent, their authority, and their power (Schwille, Porter, Belli, Floden, Freeman, Knappen, Kuhs, & Schmidt, 1983). Nevertheless, weak policies sometimes have surprisingly large effects. A good example is the state achievement testing program in Missouri. Districts are required to administer the state tests at least four times during grades 2 through 10. Districts are not required to report the results to the state. In the large urban district in Missouri, however, state tests received inordinate attention by the school board, district administrators and school administrators and, therefore, by the teachers. The district was under court- ordered desegregation, and district results on the state tests were poor. Continued desegregation funding was made contingent on improved test performance. As a result, the district superintendent's job was on the line if scores did not go up. This contingency was, in turn, passed on to school principals. Not surprisingly, pressure mounted on school teachers. In one of the schools in the Missouri urban district, teachers were required to write on the chalkboard each day the test objectives they were covering. Compliance was monitored by a school administrator. In the other school, a so-called 60/40 rule was adopted. Teachers teaching courses covering content likely to be covered on the test were required to spend at least 60 percent of instructional time on test objectives. Even more intrusive, teachers of courses not on subjects consistent with the state tests were required to spend at least 40 percent of instructional time on test objectives.

Yet a second example of a weak policy having a substantial effect was found in the rural South Carolina district. The state required that each district have a teacher evaluation program. The rural district adopted a teacher evaluation program that required teams of administrators and teachers to observe teachers. Significant amounts of training were required to become qualified to do observations, and significant amounts of time were required by the observations. In addition, the district required that each principal conduct classroom observations each day and that these observations be written up each week and reported to the superintendent.

Obviously, weak policies do not have consistently strong effects. This statement relates to the previous point about curriculum policies leading to greater diversity of practice rather than standardization of practice. The point here is that even weak policy can lead to significant response, depending on the local context.

Schools are where the strongest examples of curriculum upgrading and standard setting took place. In the Arizona urban district, one of the two high schools studied required all students to take a first-year algebra course and a first-year chemistry/physics course. The curriculum of these courses was standardized through school-level curriculum guides and school-level staff development.

Similarly, the high school in the smaller urban district in Pennsylvania had moved to eliminate all basic courses in math and science and was requiring, with some exceptions, that all freshmen take algebra. The importance of school-level curriculum policy is seen in these examples of unique school initiatives. It is seen even more so through schools' interpretation and enforcement of district and state curriculum policies. In the urban South Carolina district, one of the two high schools was following the district's lead to push increasing numbers of students into college preparatory courses. In contrast, teachers in the other school had gotten together and convinced the principal that increasing enrollment in college preparatory courses was not a useful strategy and was not benefitting students.

Two of the most frequently mentioned curriculum policy instruments deserve special mention in our analysis of high school mathematics and science. Textbooks and tests are important instructional resources that can and often do influence the nature of high school mathematics and science instruction.

Textbook adoption does not appear to have been a particularly forceful curriculum control policy in high school mathematics and science. Of our six states, only two had textbook adoption policies that applied to high schools, South Carolina and Florida. In contrast, California, the best known textbook adoption state, had textbook adoption policies only for grades kindergarten through 8. In Florida, the prescriptiveness of state textbook adoption lists was weakened because adoption lists included more than one text from which schools and districts could choose, and, further, 50 percent of state funds could be spent on materials not on the list. In South Carolina, five texts from which districts and schools can select are adopted for each subject. These are not particularly forceful policies, especially when one considers the significant involvement of teachers in drawing up the adopted textbook lists and, further, the lack of distinctively different choices available from the publishing industry. Some districts do adopt a single text for each high school mathematics and science course offered. This is most typical with the small rural districts where there is only one or possibly two high schools in the district.

The real story to be told about instructional materials, however, is not about the ways in which they are used by states and districts to control local practice. Rather, the most significant point is that instructional materials to support the curriculum reform of ambitious content for all students are simply not available. As the reform movement picks up steam, hopefully the publishing industry will respond by providing needed materials. If they do not, the reform is almost sure to fail. No matter how often and by whom teachers are admonished to develop their own materials and not be textbook followers, most teachers feel that they have neither the time nor the expertise to offer instruction without a supporting text. A good example from this study is California's Math A. There are 13 instructional units in Math A, all with example exercises, but there is no accompanying textbook. This was the single most common complaint heard from Math A teachers. As a result, a text is being developed for that course.

In some large urban districts, there is yet another story to be told about instructional materials. At least in the large urban district in Pennsylvania, textbooks of any type were not in sufficient supply. Money was not available to replace old texts or to replace texts that students lost or destroyed. As a result, student use of textbooks was tightly controlled and largely restricted to the school. The negative effects on homework are obvious.

Testing also plays a somewhat unique role as an instrument of curriculum policy control in high school math and science. First, most states and districts test mathematics in high school, but substantially fewer test in science. Thus, mathematics is a much more regulated curriculum in high school than is science. Second, in the two states with high school graduation tests, South Carolina and Florida, the effect was to increase the number of remedial courses and the amount of remedial instruction received by students. Since, in both states, only mathematics and not science was a part of the high school graduation test, more remediation was seen in mathematics than in science. Whether or not this is a positive development for students is unclear. On the one hand, many of the students receiving remedial instruction did eventually get to the point where they could pass the test and graduate. On the other hand, the material tested is material that students should master by sixth grade. In some sense, then, students limited to remedial instruction are not receiving a high school education in mathematics. Instead, they are repeating, year after year, the study of K-6 arithmetic. What really is needed is a strategy to bring students to a level of mastery prior to high school. Perhaps tests required for promotion from sixth grade and remediation, including summer school, would be a better approach. Still better would be substantially more effective elementary school mathematics instruction.

Standard Setting at the Top, Too

Standard setting in the late 1980s was, first and foremost, an effort to shore up the bottom. All students were required to take more math and science to graduate from high school. In some states and several districts, students were required to pass tests to graduate from high school or to receive course credit. Curriculum guides for subject areas and for courses specified core curricula that, at a minimum, teachers were to cover and students were to master. But at the same time as these initiatives sought to place a threshold below which no student could fall, other initiatives were being taken by states, districts, and schools to upgrade standards for higher achieving students.

South Carolina and Florida each initiated a special diploma for students seeking to attend state colleges and universities. These diplomas not only required more mathematics and science, but they also stipulated particular mathematics and science courses to be taken in meeting the requirements. For example, in Florida the regular diploma requires three years of mathematics, while the academic diploma requires four years of mathematics that must include algebra, geometry, and trigonometry.

In all states, colleges and universities were also increasing their entrance requirements. These college entrance requirements paralleled the South Carolina and Florida college prep diplomas both in requiring more science and mathematics and by specifying particular math and science courses.

Some states (e.g., California) and several districts (especially the large urban districts) were pushing for more students to take more advanced courses in all academic subjects, especially mathematics and science. These district and state initiatives were more informal than formal, sometimes captured in curriculum framework language but other times transmitted through word of mouth. Nevertheless, the push for more students to take more advanced courses was being felt at the school level. In some schools and districts, summer programs were being used so that students could complete basic and remedial work in time to take more advanced work in subsequent years. AP course taking was also receiving increased attention. In fact, the number of AP courses taught and the number of students receiving AP credit have become indicators of school success nationally and especially in specific states.

Some districts and several schools had begun a process of eliminating basic courses in mathematics and science and/or requiring that all students take first-year college prep courses in math and science. In addition, Florida and South Carolina had placed requirements on the amount of lab time that a science course must include in order for that science course to count toward graduation, although, as seen in Chapter 5, these state lab requirements were not being met in practice.

Promising Practices

Among the six states, 12 districts, and 18 high schools studied in Reform Up Close, a number of promising practices were observed. This section highlights several of them. Special attention is given to a high school in the large urban district studied in Arizona. A desegregation court ruling provided not only the impetus, but substantial funds, for making A2 a transformed high school of considerable promise. California's Math A as a bridge course to Algebra 1 is also featured as an initiative quite distinctive and with much early success. There were many other initiatives that we regard as quite promising; these are described elsewhere in this summary and in previous chapters. Among them are the elimination of remedial courses and the requirement that all students take beginning level college preparatory courses, magnet schools (although they had the down side of creaming away good students from other schools), more demanding requirements for academic diplomas for the college bound, and summer programs designed to get weaker students through remedial work in time that they could take more significant courses in mathematics and science prior to graduation.

A Special High School

In an attempt to narrow the difference in academic skills between high and low achievers, at A2 all students take algebra and a higher level core science class. The new courses at A2 are intended to better prepare underserved students and provide them pathways toward greater academic success and opportunity. The school restructuring goes beyond math and science and exemplifies how schools can change, given a vision and the resources to achieve it.

School context. Desegregation was mandated in the large urban Arizona district after attempts to close down some schools brought attention to racial imbalances. To avoid massive bussing, the district proposed creating a magnet program to attract white students to the minority schools. These original magnets produced some improvement in the district's racial balance but did not fulfill the requirements of the desegregation order. Grossly underfunded, the district was able to take advantage of the desegregation order to levy additional support. Under the desegregation order, the district proposed a plan for improving its racial balance. The judge concurred, and property taxes were increased to support the proposal without requiring passage of a bond issue.

At about the same time, a new superintendent established Self-Improvement Teams (SIT), a kind of school-based management, at each of the campuses. The SITs provided a means for teachers to take greater control of the direction of their school. The district also developed curriculum guidelines based on the state essential skills and input from teachers on what they felt should be covered in the schools. Once the guidelines were developed and textbooks chosen based on their ability to mesh with the guidelines, district-facilitated teacher committees developed course level criterion referenced pre- and posttests to yield information on the needs of students at the beginning of the term and their gains by the end of the term. A number of new district-level administrators were brought in to facilitate this process, including new directors of research, curriculum, and testing.

The school with the poorest reputation in the district, A2 also had the highest percentage of minority students. The school was unsafe, ridden with violence and gang activity. While the district had invested heavily in A2 magnets, they were unable to attract white students.

With the desegregation money, A2 hired an additional principal. The two principals developed and implemented a plan that has changed the character of the campus. In the past, students were afraid to come to school; today students can be found on campus until late in the evening working on the performing arts magnet programs.

The school developed a proposal, approved by the district, that called for an infusion of money and personnel. Seventy-five additional teachers (for a total of 200) were hired at a cost of $2.5 million. Each teacher of a subject area teaches no more than half a day, with the remainder of the day free for student tutoring, calls to parents, home visits, and curriculum development. The plan focuses on three major areas of concern at the school: safety, opportunity, and respect.

Safety. To make A2 an attractive place for students outside the local community, the school staff, community, and students made safety the number one priority. The campus has visible security personnel to monitor who enters and leaves. No student may leave during the day without staff approval. Tardiness is addressed by holding students who are late for class in a detention room where they must sit still without working or sleeping for the duration of the class period. No student may leave class for 15 minutes after the bell rings or 15 minutes before the period ends. This allows security personnel to clear the campus of nonstudents and to be sure all students are in class. Before, a hundred kids at a time could be seen roaming the campus during school hours, and fears about fights and weapons were common. Now, violence is prohibited on the school grounds, and personnel are available to enforce the ban. This approach has dramatically lowered the incidence of violence on the campus. But violence is not eliminated from the students' lives.

The students' lives are varied–some have to deal with violence in their community. In the words of an algebra teacher at A2,

> They'll call me and tell me that they were absent that day and that they're really sorry, but that they were at a park and their boyfriend shot their best friend and he was at the hospital and their best friend ran to Tucson and the police have been bugging her all night–I mean it's just incredible what they go through.

The absence rate has been reduced, and the dropout rate declined by 6 percent in the first year. After the first year of the safety program, A2 became a much better place for people to learn and work.

Opportunity. All students are assigned to the freshman core, which includes algebra, chem/physics, and English. This placement ensures that students will not take the minimalist route of general math and consumer math and graduate without learning any new math material, and it works similarly for science and English. Only a small proportion of students took algebra and biology in the past. Students who do not get through all the algebra material may, at the teacher's discretion, be given credit for general math or prealgebra. Thus, students get credit for taking the class, even though they may not have performed well enough to continue in the algebra sequence. The goal is to make sure all students complete at least the equivalent of algebra before they graduate.

The students who absolutely cannot do algebra and who get extremely frustrated with being in the algebra class are put into a special class. The other slower students are happy to be included in the class with their peers. If nothing else, they feel better about themselves being able to carry around the regular algebra book like everyone else. The middle group's self-esteem is elevated because they never thought they could do academic work, and they are surprised to find out that they can. The upper level students are better off because, in a school where it isn't cool to be smart, they are able to take the challenging class that most would have otherwise avoided.

Individualized outcome-based instruction alternatives are available for students who are highly at risk, such as teen parents, working students, and students with poor attendance patterns. These alternatives involve individually paced classes in general math and prealgebra. A2 has implemented ongoing tutoring opportunities for all students. Students may get assistance in any subject in a number of innovative ways. There is a tutoring hotline that students may call at any time of the day or night, weekdays or weekends, for help. A tutoring center on campus is open from 7:00 a.m. to 6:30 p.m. for help with any type of homework problem. On Saturdays, a bus funded by a local business picks up students in the morning at the campus and transports them to the local community college where they can study and get help with homework. Teachers are available in their classrooms during lunch hour, often before school, and during the eighth hour, which most students have as a free period for special help. On Thursdays, the class schedule is shortened to provide a 30-minute period at the beginning of the day for tutoring and makeup assignments. Students may come on their own or may be requested to attend by teachers who feel they need help.

Restructuring teacher's work. Teachers are encouraged to share instructional methods through discussion with one another and by observing one another's classes to share teaching techniques. Every teacher is provided with office space in a centralized departmental area. Each teacher has his or her own phone. Math department teachers have their own Macintosh computers at work stations. The district provides substitutes and some expense money for teachers to attend professional development workshops and conferences to improve teaching techniques and substantive skills. The district provides summer workshops on the Essential Elements of Effective Instruction, on teaching multicultural students, and on other teaching techniques. The school provides eighth-hour workshops for teachers in specific areas of interest, such as substance abuse and curriculum.

Teacher morale is very high; students feel like the teachers really care about them. In some cases, teachers call kids in the morning to be sure they haven't overslept; teachers make home visits; there is an on-site social worker for referral to social services, which have been expanded to help parents as well as kids with nonschool problems.

Mutual respect. While opportunities for special help are abundant, it is left up to the student in most cases to take advantage of the academic help or counseling. The philosophy of the staff is that students will not accept help until they admit that they need it and seek it out.

All employees at A2 are referred to as staff, including administrative personnel, teachers, and safety and maintenance personnel. All are considered equal partners in delivering the educational product. Teachers and other staff are involved in decision making on programmatic direction and curriculum development. Teachers are given the freedom to use the time they have available as a result of the infusion program to move in whatever direction they deem appropriate.

Elevating the themes of *safety*, *opportunity*, and *respect* as top priorities may appear to be a simple formula. It does require additional investment of resources for capital improvements and staff, but returns on the investment are high. Dropout rates have declined, and test scores are up to the district average. A2 is a place where learning happens. Students are challenged and, in response, they rise to the challenge. Still, a recent survey of students found that a third of the incoming freshmen feel unsafe on the campus, and there are occasional acts of violence directed toward teachers and students. Nevertheless, the school has come a long way in its metamorphosis. Teachers and students are working together and not pitted against each other as they were before the transformation.

California Math A

Originally conceptualized in the 1985 California Math Framework, Math A was designed to serve as an intermediate step for students who might otherwise have taken ninth-grade General Mathematics and still might not be ready for Algebra 1. Math A emphasizes group work, use of manipulatives, less emphasis on lecturing and more emphasis on student participation, less emphasis on specific answers and more emphasis on open-ended questions, and more emphasis on written responses and student portfolios. Developed by teachers with state support, Math A has 13 units. It is not a state requirement, but rather an option that some districts, some schools, and some individual teachers have chosen to adopt. Before a teacher can teach Math A, a five-day inservice is required. Some districts and schools have added to this minimum inservice requirement, sometimes substantially.

The course incorporates many innovative instructional and curricular ideas that are designed to give students a richer and broader mathematical experience than is typical of general math courses. Math A is designed so that students can be engaged in a mathematically rich core curriculum in the ninth grade and have the choice in the tenth grade of either entering the college track mathematics sequence or taking an alternative sequence, which may include Math B.

Students in the course. Math A is not meant to be a "dumping ground" for students who have failed other math courses. Math A is a "bridge course" that helps prepare students who do well to make the transition to Algebra 1. Algebra 1 is especially crucial for many minority students, and Math A may be the key course that determines whether they will have the option of attending college.

> A major goal of the Math A course is to get students to like math and to see themselves as succeeding at it, while at the same time keeping sound mathematical content close

> to the surface. Students beginning Math A often will have not yet seen mathematics as a powerful and beautiful subject, and few will have had positive experiences in learning it. Yet, if they are to enter the mainstream, Math A must offer them a new opportunity to see something of the real spirit of mathematics and provide them with a more concrete, hands-on, student-friendly approach to mathematics than many of them have had a chance to see before. Only then will they be motivated to solidify their K-8 mathematics skills and to approach their secondary mathematics program with positive feelings. (Stanley, 1989)

To achieve these goals, Math A needs to be taught with a more flexible class structure and more variation in classroom work than is the convention. At the same time, it is crucial that Math A be built around a strong core of solid mathematical ideas and that its students learn to use these ideas with power and with understanding.

Changing pedagogy to meet the demand of the new curriculum.

> There are two different kinds of criteria which are useful in deciding what sort of mathematics should make up the Math A course. One of these relies on seeing mathematics as consisting of a fabric of several interwoven strands; it requires that Math A present a broad and balanced selection of material from all strands. The other enumerates the basic kinds of phenomena whose description involves mathematics in an essential way and which form primitive components of other fields; it requires that Math A provide explicit treatment of the most important of these. (Stanley, 1989)

Removing the teacher as the "sage on the stage" is one of the primary objectives of Math A. This philosophy advocates the teacher as a facilitator of active learning. Students must be able to express creativity and demonstrate their understanding of mathematical concepts by being engaged in projects and open-ended investigations. This instructional philosophy encourages the use of cooperative learning. Cooperative learning moves the teacher away from whole group instruction and helps place students in situations where they must learn to communicate their understanding of math to their peers. To complement the instructional methodology, there are one- to four-week cohesive units that help bring mathematical concepts together around a theme, unlike most math courses that present one- to two-day lessons around different topics. The conventional component approach fails to give students a sense of how all the topics fit together. The approach of providing a "high intensity" curriculum strives to cover fewer topics in greater depth.

Teaching strategies include the use of manipulatives and concrete experiences, calculators, reading, and writing to enhance students' understanding of mathematical language, drawing visual representations, mathematical modeling, and problem solving that support the development of an applicable understanding of mathematics.

The course guide. A course guide provides teachers with the overall course perspective and mathematical ideas, but it is not a textbook package with tear-out fill-in-the-blank answer sheets. An annotated reference guide is provided to help teachers locate appropriate materials. The demands of this course on a teacher's ability to change the traditional way of teaching mathematics are substantial, requiring--at the least--ongoing professional development activities, classroom support, and available classroom resources to adapt teaching to a "hands-on" style of teaching for understanding.

The goals of Math A are (1) to develop a spirit of inquiry and excitement about learning mathematics, (2) to generate in students a sense of responsibility for developing the skills they will need, and (3) to provide students with powerful mathematics content that will enable them to deal with new situations. The course guide begins with an opening unit requiring six to nine class periods to cover the mathematical content of number (timelines and number lines, multiples, fractions), algebra (order of operations), and logic (spatial reasoning, deductive thinking, and Venn diagrams). Other content includes the following: a unit on surveys and data analysis, which requires students to compile, analyze, and interpret survey data; a unit on spatial visualization, emphasizing geometry and measurement; a unit on large numbers, in which students learn to estimate, select appropriate units of measurement, and reason proportionally; a unit on fencing and packing, in which students explore relationships between perimeter, area, and volume; a unit on chance, in which students conduct simple probability experiments and learn to distinguish between empirical results and theoretical probabilities; a unit on graphical interpretation in which students make and interpret graphs; a unit on growth and decay, which covers a broad array of measurement, geometric, and algebraic concepts; a unit on balancing, which covers intuitive understanding of first- and second-degree polynomials and other algebraic concepts; a unit on sequences and sums, covering sequences, variables, functions, and simple equations; a unit on motion, which emphasizes learning to model data; a unit on rectiles, which covers algebraic and geometric concepts, including rotations and reflections, congruence and similarity; and a unit on math and nature, which attempts to connect mathematics to other fields, including biology, architecture, and art.

The course emphasizes mathematics embedded in real world problems, data collection and interpretation, and mathematical modelling.

Implementation of Math A. In Reform Up Close, Math A stood out from all other courses studied as having a distinctive dual emphasis on algebra and geometry, with algebra being the slightly more heavily emphasized content area of the two. Sixty percent of instruction was comprised of algebra and geometry for the Math A course in the analysis file, and 82 percent for the Math A course for which data on only a half year of instruction was available. Further, within geometry both solid and coordinate geometry were emphasized, two topics that were not emphasized in first-year geometry courses in the log sample.

The finding of dual emphasis on algebra and geometry is consistent with the Math A course syllabus. However, implementation of that syllabus was not perfect. The 13 course units include instruction on both probability and statistics, but neither of these content areas were reported as taught in either of the two sections. Contradictorily, the questionnaire data for those same two sections of Math A indicated that probability and statistics were included. However, for those Math A course sections, teacher questionnaire data were prospective and collected midyear in 1989-90. Log data described instruction as it unfolded during the spring of 1989-90 and the fall of 1990-91. Perhaps the teachers intended to cover probability and statistics, recognizing that it was a part of the curriculum. Apparently, however, those topics fell victim to other pressures. Unfortunately, there is nothing in our data base that helps to reveal what those other pressures might have been and how they could have been alleviated.

One lesson may be that adding probability and statistics to the high school mathematics curriculum, as called for in the NCTM *Standards*, may be especially difficult. There was little to no probability and statistics taught in any of the standard math courses in the log sample. That the emerging curriculum had not yet touched these traditional courses was disappointing but not surprising. That probability and statistics were not taught even in Math A, where those content areas were explicitly a part of the plan, was both surprising and disappointing.

Math A not only stood out as distinctive from other math courses in its emphasis on algebra and geometry, but it also stood out as having an unusually high emphasis on mathematical modelling and an unusually low emphasis on exposition. Similarly, the two Math A courses placed unusually high emphases on collecting data and solving novel problems and put less emphasis on computation. Again, both of these findings are consistent with the design of the course and very much consistent with the curriculum reforms of the late 1980s.

At least as seen in the two Math A sections for which log data were available, Math A represents a unique bridge-course opportunity for students. Both the content and the pedagogy of Math A instruction were more consistent with late 1980s curriculum reforms than were the content and pedagogical emphases of other math courses studied. Whether or not the course is effective in bridging students on to more advanced mathematics could not be determined from the data collected. (Questions of the effect of Math A and other related questions were so intriguing that we are following up with a separate study of Math A funded by the U.S. Department of Education, Office of Educational Research and Improvement). What is clear, however, is that students taking Math A are receiving a curriculum that sharply contrasts with that of general mathematics, that involves learning new content, not just rehashing the grades K through 8 curriculum once again, and that actively engages students in coming to understand mathematical concepts and how to apply them.

Disappointments

While a number of promising practices were identified, there were a number of disappointments to be found in the policy landscape, as well. First among them is that nowhere did we see leadership and accompanying policy initiatives that appeared up to the challenge of bringing about the reform of ambitious content for all students in high school mathematics and science. At the state level, California was furthest ahead with its highly visible state frameworks and its Math A bridge course. Since our study, California has taken another important step forward by eliminating its old testing programs and, in their place, putting performance assessments in each of the core academic subjects and at all levels of schooling. The performance assessments require all students to demonstrate their ability to reason, solve complex multistep problems, apply their conceptual knowledge, and communicate.

But even in California, important pieces of needed policy support were absent. With the exception of Math A, staff development was episodic, fragmented, and too often uncoupled from the state curriculum framework and the content that students are to learn. Neither were there instructional materials necessary to support the curriculum framework. Finally, while tracking was targeted for elimination, not only at the state level but in several districts, tracking remained alive and well in our California high schools. California may, over time, add these missing pieces of solution to its overall impressive start. Short of that, the curriculum reform of ambitious content for all students in California will have variable and generally quite limited success. Some teachers, even some whole schools, will change their instruction in important and useful ways. Others will adopt the rhetoric of the reform, but not the practice. The change required is simply too large and too difficult for most teachers and schools to make without receiving much more leadership, encouragement, and support than we found. In contrast to California, most of the policies and practices we found in South Carolina and Florida stood as barriers to the goal of ambitious content for all students.

At the time of our study, however, systemic reform was a relatively new idea (Smith & O'Day, 1990). Since then, both the goal of ambitious content for all students and the approach of systemic reform have become highly visible. The National Science Foundation has invested tens of millions of dollars in states across the country to promote systemic reform in mathematics and science. At this writing, it remains too soon to tell whether all of the attention and investment will result in significant state, district, and school change. Our description of the policy landscape in 1990 makes clear the enormous magnitude of the change needed.

The quality and amount of staff development is a second and closely related major disappointment. The U.S. Department of Education makes millions of dollars available each year for staff development in mathematics and science. Yet, at least in our six states, these funds were not used strategically to support statewide curriculum reform. Neither did we find evidence that any of our 12 districts had made strategic use of these Eisenhower funds. In addition to the federal investment, states also invest in staff development, as do districts. Occasionally, there is evidence of a coherent and significant program, for example the required training for Math A in California and perhaps the Florida summer workshops in math and science. More typically, however, what appear to be large investments at an aggregate level (e.g., nation or state) amount to trivial amounts at a teacher level (Eisenhower funds averaged $30 per teacher). Most programs are voluntary; the most highly motivated, least in-need teachers get the greatest benefit from the investment. With one exception, school A2 in Arizona, we did not see schools taking appropriate responsibility for providing teachers the necessary staff development support.

We conclude that in 1990 most of the investment in staff development to improve high school mathematics and science was wasted. Too much of the training focused on process uncoupled from curriculum frameworks and course syllabi. Training was short-term, fragmented, and episodic. Staff development was designed and delivered by people distant from the school and generally not knowledgeable about school and teacher needs. We conclude that staff development should be just the opposite, primarily designed and delivered at the school level, focused on the academic content that students are to learn, sustained and programmatic in nature, and required of all teachers.

We were equally disappointed with the programs of teacher evaluation that we saw in the states, districts, and schools studied. Most districts had teacher evaluation programs, whether or not they were required by the state. In all schools studied, some type of teacher evaluation was conducted. Invariably, teacher evaluation focused on process and pedagogical strategies to the exclusion of any concern for the quality of the course syllabus or, more importantly, the quality of content in the enacted curriculum. Despite the prevalence of teacher evaluation programs, not once did we hear from a teacher that teacher evaluation was a significant influence on their practice. One ray of light in an otherwise bleak picture of teacher evaluation was teachers working with other teachers. In addition to a few formal evaluations requiring teachers to observe teachers, we found a few instances where teachers were encouraged to observe each other (e.g., the Arizona rural district) or to collaborate on semester exams (Arizona A1).

Generally, high school mathematics and science teaching appears to be a isolated experience. Math and science teachers reported on the questionnaire spending an average of only 3.7 hours per month working with other teachers on instructional issues. If the goal of ambitious content for all students is to be achieved, clearly teachers will need the opportunity to see good examples of such instruction, and they will need feedback on their own instruction against that goal. Peer observation and teacher collaboration are likely useful strategies.

Exacerbating the weaknesses in staff development and teacher evaluation is yet one more of our disappointing findings. Far too many teachers, 12 percent of the math and science teachers surveyed in the 18 schools studied, were teaching at least one math or science course without appropriate certification. These percentages varied from state to state, with a high of 32 percent of California teachers teaching at least one math course without math certification and a high of 23 percent of Arizona teachers teaching at least one science course without science certification. Blank and Dalkilic (1990) report that, for the six states in our study, one-third of high school teachers of mathematics did not major in mathematics or mathematics education in college, and one-third of high school science teachers did not major in science or science education in college. (Percentages for the Reform Up Close sample of teachers were comparable, 30 percent in mathematics and 44 percent in science.) Clearly, subject matter knowledge remains a significant problem in mathematics and science, even at the high school level. Staff development not only needs to be improved, but it must give significant attention to upgrading teachers' subject matter knowledge as well as strengthening their pedagogical strategies.

Another disappointing finding concerned the instructional resources available to teachers and students. The increased graduation requirements in science had put an enormous strain on science departments. Not only were science teachers in short supply, but science laboratories were not available for many of the science courses being offered. In most cases, teachers had to staff their own science lab, if they had access to a science lab at all. Maintaining and setting up a science lab is time-consuming work; it's no surprise that little lab work is actually incorporated into science instruction. In mathematics, what few computers were available for instruction were used for drill-and-practice remediation. There was little evidence of computers being used for significant mathematical work, and few graphing calculators were in evidence either.

With the exceptions of science labs and computers and calculators for mathematics, most teachers and education administrators thought instructional supplies were adequate. Large urban districts not under court-ordered desegregation are an important exception. In those districts, money was simply not available to purchase ordinary school supplies. In the Arizona and Missouri urban districts, funding had been increased dramatically due to desegregation orders. At least in the case of the Missouri urban district, however, the increase in funding was temporary.

The Enacted Curriculum in High School Mathematics and Science

The information collected through daily teacher logs and the information collected through teacher questionnaires allow a comprehensive and detailed description of high school mathematics and science instruction, at least as taught in high schools serving high concentrations of low achieving students. The questionnaire data represent all mathematics and science courses and all mathematics and science teachers in the high schools studied. In contrast, the log data are more selective, providing detailed descriptions of the enacted curriculum for courses experiencing the largest gains in enrollment following increases in math and science graduation requirements.

By comparing the enacted curriculum as described by the questionnaire data to the enacted curriculum as described by the enrollment-gaining courses in the log data, it is possible to see whether or not increases in enrollment compromised the curriculum in either math or science. If large influxes of new students, presumably less qualified, did bring about a "watering down" of the curriculum, then the courses described by log data would look weaker than courses with the same titles in the larger questionnaire sample. The log data provide yet another check on the effects of increased numbers of students taking mathematics and science. Two of the math courses, both Algebra 1, were in schools that required all students to take Algebra 1. One of the science courses, Chemistry/Physics, was in a high school that required it of all students. Comparing these required courses to other courses in the log sample with the same titles but not the requirement for all students provides yet a second check on the "watering down" hypothesis.

Collectively, the questionnaire and log data provide a fine-grained snapshot of the nature of high school mathematics and science at a key point in education history. At the time the data were collected, the standard-setting initiatives of the 1980s had been put in place and any effects should be in evidence. In contrast, the curriculum reforms to move mathematics and science instruction toward greater emphasis on applications, solving novel problems, and deeper conceptual understanding were just beginning. The NCTM *Curriculum Standards* and the AAAS *Science for All Americans* had just been published (in 1989). Thus, our rich descriptions of the enacted curriculum allow an assessment of standard setting on the one hand while providing a baseline for the professional society led curriculum reforms on the other.

The Influence of Increased Enrollments in Mathematics and Science on Student Opportunity to Learn

For each type of math and science course, comparisons of the questionnaire sample to the log sample uncovered only minor differences in what was taught. Thus, the more heavily subscribed log sample courses showed few, if any, signs of being weaker than the questionnaire courses taken by fewer students. For example, the content of Algebra 1 looked much the same, regardless of whether or not the Algebra 1 section was in a school where Algebra 1 had experienced large increases in enrollment. Biology looked much like Biology regardless of the percentage of the student body taking the course. For math, there was a slight tendency to find a greater emphasis in the questionnaire sample on solving novel problems and developing proofs than in the log sample, but this finding can be dismissed as an artifact of the differences in the data collection strategies. Questionnaire data asked teachers to report, for each topic, the highest level reached among the options; memorize, routine problems, novel problems, develop proofs. Even the slightest attention to developing proofs received a higher weight in the questionnaire sample than it did in the day-by-day reporting of the log sample. For science, log sample courses put a relatively lower emphasis on general science topics (e.g., the nature of scientific inquiry) than did the questionnaire sample. This difference, while valid, is not suggestive of any watering down in log sample courses. Some might say just the opposite, that the more serious science courses would place greater emphasis on topics of biology, chemistry, and physics than on general science topics such as the nature and structure of science or the nature of scientific inquiry.

Required courses. The three required courses in the log sample provide a somewhat stiffer test of the hypothesis that the curriculum upgrading strategy of increasing enrollments in advanced courses results in those courses no longer being advanced. For the two Algebra 1 courses required of all students, one emphasized algebra (as opposed to other content areas such as arithmetic) even more than was true for the average of all Algebra 1 courses in the log sample. The other required Algebra 1 course emphasized algebra only slightly less than the average for all Algebra 1 courses. When looking more closely at the types of algebra topics emphasized, both required courses put greater emphasis on advanced topics than was true for the average of all Algebra 1 courses. The required Algebra 1 course with the greatest emphasis on algebra topics also put an unusually high emphasis on nonlinear equations. The other required Algebra 1 course placed a higher emphasis on work involving systems of equations, a topic more likely to be taught in Algebra 2 courses than in Algebra 1 courses. Despite the fact that all students were required to take them, both of the two required courses looked much more like Algebra 1 courses than they looked like Prealgebra courses. Neither course looked anything like General Math.

When extending the analysis of the two required Algebra 1 courses to consider modes of instruction and intended student outcomes, still there was no evidence that the enacted curriculum had been watered down. The required Algebra 1 course that placed the highest emphasis on algebra also placed a higher emphasis on work involving equations/formulas than did Algebra 1 courses in general. Otherwise, the curricula of the two required courses matched that for Algebra 1 courses in general on modes of instruction. Both required courses placed a lower emphasis on computation than did Algebra 1 courses in general. The required course that placed the greatest emphasis on algebra made up for its relatively lower emphasis on computation by stressing student understanding and memorizing facts. The other required Algebra 1 course replaced the typical emphasis on computation with a relatively greater emphasis on work involving solving routine problems such as story problems. If anything, this finding represents a stronger curriculum for that required course than for Algebra 1 courses in general.

Similarly for the required Chemistry/Physics course there was no evidence that increased enrollments had weakened the content of instruction. The required Chemistry/Physics course looked almost identical to a college prep Physical Science course in the sample, with both courses devoting 37 percent of instructional time to chemistry, 37 percent to physics, and 24 percent to general science. Within these content areas, the required Chemistry/Physics course placed a greater emphasis on atomic and nuclear structure and energy and less emphasis on chemical properties and processes and organic chemistry than did the college prep Physical Science course. These differences are not suggestive of a watering down, but rather simply a difference in substantive focus.

When considering modes of instruction, the required Chemistry/Physics course relied less heavily on written and oral exposition than either the college prep Physical Science course or Physical Science courses in general. Instead, the required course placed a relatively greater emphasis on work involving pictorial and concrete models (28 percent of instructional time), suggesting that the required course provided a better quality of instruction than either Physical Science courses or the college prep Physical Science course. A similar positive finding was found for expected student outcomes. The required Chemistry/Physics course placed less emphasis on students memorizing facts and more .

emphasis on students replicating experiments than did either the college prep Physical Science course or Physical Science courses in general.

Thus, no evidence was found that requiring more students to take more advanced mathematics and science resulted in compromising the curricula of the courses experiencing the increased enrollments. Algebra 1 remained Algebra 1, regardless of whether all students were required to take it. The required Chemistry/Physics course looked as challenging in terms of topics covered as did the college prep Physical Science course, and the actual quality of instruction looked better.

Similarly, from the questionnaire data, math and science teachers reported that in the past three years they were nearly as likely to have revised their course content to be more difficult (23 percent of the teachers) as they were to have revised their course to be less difficult (32 percent of the teachers).

Course level versus class ability. The regression analyses provide yet another look at the question of whether or not increased enrollments in math and science courses, brought on by increased high school graduation requirements, resulted in a watering down of the curriculum. In regressions to predict classroom content and pedagogy, predictors included School Ability, School Behavior, Class Ability, and Course Level. If increased enrollments had served to compromise the curriculum, then Class Ability should be a stronger predictor of course content and pedagogy than Course Level. If, in contrast, the course curricula had not been compromised, Course Level should be the stronger predictor. Obviously, in either case, both Class Ability and Course Level could be expected to predict content and pedagogy; it is the comparison of their strengths of prediction that is most important here.

For predicting emphasis on mathematics topics (Dimensions A and B of the taxonomy), Course Level was much the stronger predictor than Class Ability. These results held for both questionnaire and log data and were especially true for topics of Number, Arithmetic, and

Measurement, all of which were emphasized more in low-level courses, and for Algebra, Trigonometry, and Precalculus, all of which were emphasized more in high-level courses. The one exception to this strong pattern is Geometry, which was not predicted by either Course Level or Class Ability but had a significant negative relationship with School Ability; schools serving student bodies judged to be of relatively low ability have math courses that put a greater emphasis on geometry than do schools serving student bodies of higher ability.

Science topics (Dimensions A and B of the taxonomy) were less well predicted by either Course Level or Class Ability than were math topics. For log data, Physics had a strong negative relationship with Course Level. Low-level Physical Science courses were the courses in the log sample containing physics; there were no Physics courses in the log sample. In the questionnaire sample, Biology of Other Organisms and Biology of Populations both had significant positive relationships with Course Level and significant negative relationships with Class Ability. Thus, these two topic areas tend to be taught to relatively low-ability classes taking relatively high-level courses. For the science sample, there was a similar finding for Breadth of coverage; high-level courses had a greater Breadth of coverage and so did low-ability classes.

Three pedagogical variables were predicted by Course Level, but not Class Ability. Teacher Demands on students and Breadth of coverage both had positive relationships with Course Level. Higher-level courses are more demanding and have a greater breadth of coverage. In contrast, an emphasis upon Active student Learning had a significant negative relationship with Course Level. Lower-level courses placed a greater emphasis upon active learning, probably reflecting greater innovation in lower-level courses including bridge courses and freshman college prep required courses. For the mathematics sample, Active Learning had a significant negative relationship with School Ability, in addition to its negative relationship with Course Level. For log data and the math sample only, emphasis on Graphs was positively predicted by Course Level, but not Class Ability.

Emphasis on Routine Problems and replicating experiments and proofs had significant negative relationships with both Course Level and Class Ability. This desired student outcome was more emphasized in lower-level and lower-ability classrooms. In contrast, emphasis on Theory/Proofs had significant positive relationships with both Course Level and Class Ability.

While the above results suggest that increased enrollments did not bring about a watered down curriculum, there were a few other results less consistent with that conclusion. Emphasis on Higher Order Thinking and problem solving had a significant positive relationship with Class Ability but was not predicted by Course Level. Higher ability classes received greater emphasis on Higher Order Thinking, problem solving, and reasoning, regardless of the course level. From the log data, use of concrete models as a pedagogical strategy was positively predicted by Class Ability but not Course Level, as was the extent to which teachers worked with other teachers in Planning their instruction. Finally, use of calculators was positively predicted by Class Ability but not predicted by Course Level.

Computer Use and frequency of Student Report writing both had negative relationships with Course Level and positive relationships with Class Ability. Thus, computer use is more emphasized in lower-level courses, reflecting the use of computers for delivering drill-and-practice instruction. Holding Course Level constant, however, computers were used more frequently with higher-ability classes. Lower-level courses also put greater emphasis on student report writing, a result similar to that seen for active learning. But holding course level constant, higher-ability classrooms participated more in Student Report writing.

The amount of class time devoted to academic instruction was predicted significantly and negatively by Course Level in the math sample and significantly negatively by Class Ability in the science sample. Thus, in mathematics, lower-level courses are more likely than higher-level courses to use a larger fraction of instructional time for noninstructional purposes. In science, however, it is the lower-ability classes that are more likely to have a relatively large fraction of instructional time used for noninstructional purposes.

Science lab requirements. As an additional upgrading strategy, two of the six states required that a minimum amount of lab time must be included in science courses in order that those courses count toward graduation. In Florida, at least 40 percent of instructional time in science courses was to be spent on lab work; in South Carolina the requirement was that 20 percent of science instruction be spent on lab work. The log sample science courses provide a good test of the impact of these state science lab requirements.

Of the ten Florida and South Carolina science courses for which a full year of log data were available, not one met the state requirement for lab work. In Florida, the percentages of instructional time for lab work for the five science classes were .03, .21, .21, .00, .07. For South Carolina, the percentages of instructional time for lab work were .05, .07, .09, .11, .11. The log sample science course mean for lab work was .10, with a standard deviation of .067. The Florida mean matched the total sample mean of .10, while the South Carolina mean was only slightly less, .09. Clearly, state requirements for lab work had no effect on actual instructional practice. This lack of effect occurred despite the fact that Florida required schools to send forms certifying that the lab requirement was being met; some funding was conditioned upon these assurances.

The lack of intended effect of the state requirements for lab work in science stands in sharp contrast to the positive findings concerning efforts to increase student enrollments in math and science. The lab work requirement required changes in what schools and teachers do. In contrast, the graduation requirement and course requirement strategies required students to change but not schools and teachers. This distinction, between the requirements for schools and teachers that do not have the intended effects and requirements for students that do have the intended effects, does not hold up perfectly. California Math A requires teachers to teach a new and distinctive curriculum. In contrast to the state lab requirement, however, two potentially important distinctions can be made. First, the lab requirement asks teachers to change the way that they teach courses that they have been teaching for some time. Chemistry teachers are to teach chemistry, but they are to teach chemistry while providing more lab experiences for students. In contrast, Math A does not require a change in procedures for a continuing course, but rather represents a whole new course never taught before. Perhaps it is easier to do something right the first time than it is to change in midstream. Old habits die hard. Second, Math A was introduced and supported by tailored teacher training programs and a detailed syllabus. The Florida and South Carolina lab requirements were simply requirements with no elaboration, no special support, and no real monitoring for compliance.

Professional Standards and the Enacted Curriculum in High School Mathematics and Science

The questionnaire and log data provide a description of the enacted curriculum in high school mathematics and science courses (in high schools serving high concentrations of low-achieving students) at a level of detail not previously available and in a language that facilitates comparisons and contrasts across courses, schools, districts, and states. This rich and comprehensive description of high school mathematics and science classroom practice can be contrasted to calls for curriculum reform from professional societies, especially the NCTM *Curriculum Standards* and the AAAS *Science for All Americans*. Because the initiation of those curriculum reforms roughly corresponded in time to the dates for data collection, the descriptions cannot be taken as an evaluation of progress toward realizing those reforms. Rather our descriptions of classroom practice provide a baseline from which can be seen the types of changes necessary. As was seen in Chapter 5, implementing the reforms will require many and substantial changes from current practices.

What topics are taught. The math courses in the log sample provide few surprises, though some disappointments, about the content of instruction. Basic math courses consisted primarily of arithmetic and measurement, with a few of the basic courses also including significant emphasis on algebra. Algebra courses were dominated by algebra content. Eighty-three percent of instructional time was on algebra for Algebra 1 courses, and 88 percent of instructional time was on algebra for Algebra 2 courses. Across Algebra 1 and Algebra 2, most of the algebra subtopics were covered at least to some extent. Exceptions were sequences and series and matrix algebra, two topics receiving essentially no emphasis in any of the algebra courses. Prealgebra stood midway between basic math courses and Algebra 1 courses, with a dual emphasis on arithmetic (34 percent of the time) and algebra (43 percent of the time). The algebra covered in Prealgebra was extremely narrow in focus, limited to expressions and linear equations. Geometry courses emphasized geometry content; on average 78 percent of instructional time in Geometry courses was spent covering geometry content. Most geometry topics were covered, at least to some extent, with the exception being transformations, which received no attention. Precalculus was the broadest math course in terms of range of content covered. In contrast to Algebra courses, Precalculus did include work on sequences and series, and, in contrast to Geometry courses, Precalculus did include coordinate geometry. Nevertheless, even Precalculus had no coverage of polar coordinates.

For mathematics, the big news was not so much what content was covered in traditional courses but rather, in comparison to the NCTM *Standards*, what content was not covered. None of the math courses studied gave significant attention to statistics, probability, or discrete mathematics. Precalculus did give some attention to probability, but only the most elementary probability topics. For example, Precalculus did not include empirical probability, conditional probability, nor any attention to discrete or continuous distributions.

Content coverage in mathematics courses was quite focused. For example, for each course type studied in the log sample, three or fewer of the ten levels of Dimension A were needed to account for 80 percent of instructional time. The picture for science courses was one of much greater breadth of coverage, at least for General Science, Life Science, and Biology courses. Of the 68 topics in science defined by Dimensions A and B of the content taxonomy, on average 46.8 were included in General Science courses, 48.6 were included in Ecology courses, and 36 were included in Biology courses. For mathematics, on average, only 28.2 topics defined by Dimensions A and B were covered by a course, despite the fact that the taxonomy defined almost half again as many AB topics for mathematics (94) as for science (68).

Despite the greater focus on a relatively fewer number of topics in most types of mathematics courses than in most types of science courses, the depth of instruction did not differ much between mathematics and science. Depth of instruction was defined as the number of different ways that a topic was taught (modes of instruction) in combination with the number of different intended student outcomes (e.g., understanding, memorization, computation). What was most striking was the general lack of depth of instruction for any course in the sample. The taxonomy provided 63 different combinations of modes of instruction and intended student outcomes for each topic defined by Dimensions A and B. Nevertheless, on average, a topic was taught in only 3 or 4 of the possible 63 combinations of modes of instruction and intended student outcomes. This finding varied little from course type to course type and held for both mathematics and science.

In addition to relatively greater breadth of coverage in science courses than in mathematics courses, there was another finding about topic coverage in science that stood out. Chemistry was dominated by chemistry content, Earth Science was dominated by earth science content, Physical Science was a combination of physics and chemistry, and General Science was a combination of physics and chemistry plus general science content. However, Biology was much less straightforward. Some biology courses looked more like broad survey courses of all science than they looked like biology courses. Other biology courses covered all of the main content areas in biology (biology of the cell, human biology, biology of other organisms, and biology of populations).

Other biology courses were survey courses of all biology content but with an additional emphasis on chemistry. Still other biology courses focused almost exclusively on the content of biology of other organisms. Knowing that a student has taken Biology says relatively little about what content that student has studied. The same can be said for Life Science courses which are essentially biology courses themselves.

Collectively, the science courses studied in the log sample covered virtually all of the science topics as defined by Dimensions A and B in the taxonomy. Thus, unlike mathematics, there were not whole areas of science missing from the high school curriculum. There were two general science subtopics, however, that received virtually no attention, history of science and ethical issues in science.

How those topics are taught. Both mathematics and science courses were dominated by exposition, either verbal or written, as the primary mode of instruction. In mathematics, exposition was especially high in the lower-level courses, consuming two-thirds to three-fourths of instructional time. In science, reliance on exposition as the mode of instruction was less predictable, at least by course level. In both subjects and for virtually all of the course types studied, students spent the majority of their time either being talked to by the teacher or working independently at their desks. On average and for both math and science, one-third of the time was spent in seatwork, while only 25 percent of the time was spent in class discussion and small-group work. There was very little lab work in either mathematics or science. What little lab work was done in mathematics consisted almost entirely of drill and practice at a computer terminal. In science, half of the courses in the log sample spent 5 percent or less of instructional time in lab work. The relative emphasis on lab work was specific to a particular course section and did not vary by course type. For example, the relative emphasis upon lab work was no greater for chemistry courses than for physical science courses. In neither mathematics nor science was there any field work to speak of. Nor did either subject involve students much in graph work, with only 1 percent of instructional time spent on graph work in science and a surprisingly low 4 percent of instructional time for graph work in mathematics. One potentially bright spot in an otherwise very traditional picture of instruction was the use of pictorial models in science. On average, 15 percent of science instructional time involved pictorial models, and there was relatively little variance in the use of pictorial models across different science course types.

What emerges, then, from the information on modes of instruction is a great deal of teacher lecture and student independent seatwork, with very little emphasis on active engagement of students in the construction of their own knowledge. The gap between actual practice and the curriculum reforms of the late 1980s was especially large.

Testing, textbooks, and homework. Both mathematics and science teachers reported using a textbook as the basis for instruction in slightly more than half of the days of instruction for which logs were kept, 58 percent of the days in mathematics and 55 percent of the days in science. The frequency of testing (including teacher testing as well as external testing) was similar between the two subjects, as well. In mathematics, testing was done on 13 percent of the days, and in science, 10 percent of the days. This frequency of testing translates into a test approximately every other week. Homework was quite frequent in both subjects, but more so in mathematics. Homework was assigned 75 percent of the days in mathematics and 60 percent of the days in science. Further, the mathematics work was much more likely to be corrected by the teacher, 55 percent of the time, than was science work, 29 percent of the time.

These statistics for use of instructional materials and homework are not particularly striking or revealing in terms of the study objectives. Some might be surprised, however, by the fact that teachers indicated using textbooks much less than all the time.

What are the intended student outcomes of instruction? The picture for intended student outcomes (i.e., What is it that students are to know and to be able to do as a result of instruction?) parallels the picture for modes of instruction. Again the gap is large between the enacted curriculum for high school science and mathematics courses and the desired curriculum as reflected in the curriculum reforms led by professional societies. In mathematics, the emphasis is on understanding and computation (i.e., routine procedures); in science, the emphasis is on memorizing facts and understanding. In mathematics, only 4 percent of instructional time is given to collecting and interpreting data. Only 2 percent of instructional time is devoted to students working with novel problems. On average, no instructional time is allocated to students learning to develop proofs, not even in geometry. In science, the picture is similar. Essentially no time is allocated to students designing experiments or building and revising theory. For one-third of the science courses studied, no time was allocated to data collection and data interpretation.

A possibly encouraging finding is the substantial fractions of instructional time devoted to developing conceptual understanding, 30 percent in mathematics and 43 percent in science. However, when the focus on developing conceptual understanding is considered in the context of the nature and depth of instruction, there is considerable room for pessimism. Apparently student understanding is to be accomplished through students reading and listening to lectures. Passive learning is the dominant mode of instruction. Students receive little support for becoming the active learners that they must be if they are to construct their own knowledge in ways that hold high probability for deep conceptual understanding that leads to successful application and reasoning.

Policy and Other Predictors of Classroom Content and Pedagogy

Questionnaire and log sample data were used to determine whether and how state curriculum policies and practices and other variables, including school climate, class characteristics, and teacher characteristics, predicted classroom content and pedagogy. These regressions were reported in Chapter 6. Here we summarize the findings for state policies, contrasts between mathematics and science, school climate, class characteristics, and teacher characteristics. Findings concerning Course Level versus Class Ability as predictors of content and pedagogy were already summarized in the section on the influence of increased enrollments.

Policy

State policy was represented in the regression equations as a variable labelled Group, contrasting California and Arizona on one extreme, with Florida and South Carolina on the other, and Pennsylvania and Missouri in between. This variable represented a scale of state emphasis on higher order thinking and problem solving versus basic skills. For the questionnaire sample, individual states were also used as predictors; these state regressions helped to clarify some of the findings for the Group variable. There was also a variable labelled Policy, a scale created from questionnaire items that captured teachers' perceptions of the presence and degree of influence of state and district testing, curriculum guides, and graduation requirements. Neither Group nor Policy was an especially strong predictor of classroom content and pedagogy.

For the questionnaire sample, Group was a significant positive predictor of Active Learning. Math and science instruction in California and Arizona placed a greater emphasis on active learning than did math and science instruction in South Carolina and Florida. This finding is consistent with the hypothesis that led to the construction of the Group variable. On the log sample, Group was a significant positive predictor of Student Report writing, teacher use of Concrete Models, and Small-Group instruction. These findings, too, are consistent with the hypothesis that led to the construction of the Group variable. For the log sample, the amount of Professional Reading reported by teachers and the amount of Planning with other teachers were both positively predicted by Group; while for the questionnaire sample, the Number of Times a teacher was Observed was significantly negatively predicted by Group. Thus, California and Arizona teachers were more involved in planning instruction together and professional reading while the more directly regulated South Carolina and Florida teachers were more frequently observed. For the math sample, both Calculator Use and Computer Use were positively predicted by Group. The positive relationship of Calculator Use to Group was especially true because of high calculator use in California mathematics classes, a finding consistent with the intent of the California Mathematics Framework. For Computer Use, while Group was a positive predictor, computer use in South Carolina mathematics classrooms was also high. (This is probably a result of the use of computers for drill-and-practice preparation for the BSAP exam.)

Policy was a significant positive predictor of the Change scale. The more numerous and influential the state and district curriculum policies, the more teachers were likely to have changed their course and school practices within the last three years.

State and district curriculum policy in the six-state, 12-district, 18-school sample was complicated and not easily reduced to parsimonious policy variables. Group, Policy, and State variables represented crude approximations to constellations of policies that were not particularly internally consistent or coherent, explaining to some extent the lack of significant predictive relationships between policy variables and classroom practices. Additional explanations are the lack of strength and consistency of the state and district curriculum policies. On the other hand, the few significant relationships found were largely consistent with policy intents.

Subject

One of the consistently strongest predictors of classroom content and pedagogy is the distinction between mathematics and science. On the one hand, science courses were more likely than mathematics courses to emphasize Active Learning, Higher Order Thinking and problem solving, Student Report writing, and Data Collection. On the other hand, science courses placed more emphasis upon students' Memorizing Facts than did mathematics courses. Mathematics places greater emphasis than does science on performing Procedures, including computation, use of Equations and Formulas, and Calculator Use. Testing was more frequent in mathematics than in science, as was Corrected Homework as a pedagogical strategy.

While the contrast of mathematics versus science was a strong predictor for many content and pedagogical variables, there were several important classroom practices not predicted by this subject matter distinction. For example, emphasis upon student Understanding, use of Graphs, use of Computers, and emphasis upon Theory/Proof were no more likely in mathematics than in science. Neither were Teachers any more Demanding of their students in one subject than another.

School Climate Variables

School Climate variables are Leadership, Resources, Institutional Support, Shared Beliefs, Teacher Control, and teacher Collegiality. All are defined by scales based on questionnaire data and describe the school from the teacher's perspective.

The six school climate variables were not particularly strong predictors of classroom content and pedagogy. Resources positively predicted Computer Use and Calculator Use, as one might expect. Resources had a significant negative relationship with instructional emphasis on Memorizing Facts. Thus, schools with fewer resources placed a greater emphasis upon memorizing facts. This result is not explained away by a likely confounding between inner-city schools and rural schools, since approximately half of the inner-city schools were especially well funded through desegregation money.

Of the six school climate variables, teacher Control was the single best predictor of classroom content and pedagogy. Teachers reporting being more in Control were less likely to be Observed, less likely to emphasize Routine Problems in their instruction, and, in the log sample, less likely to use Small-Group instruction. These results are consistent with the finding that the more controlling states and districts also emphasized basic skills, drill-and-practice type instruction. In the math sample, teachers emphasizing content on Number and number relations reported being less in control, a finding which fits the same pattern.

Teacher control does not always lead to higher probability of desirable classroom practices. In the science sample, teachers reporting being more in Control also reported covering a greater Breadth of topics, a finding that runs counter to the belief that curriculum control forces teachers to favor breadth over depth of instruction. Also in the science sample, Teacher Control was a positive predictor of teacher use of Noninstructional Time.

Class Characteristics

Class size was rarely a significant predictor of classroom content or pedagogy. Class size was negatively related to emphasis on Precalculus content. Precalculus is content taught in only the most advanced courses where few students are enrolled. Class size was also a negative predictor of Change for the total sample, but not in the more heavily regulated math sample. There was no evidence, however, that Class size had an independent predictive value for any of the variables that distinguished quality of instruction.

Classes studied also were described according to the percent of female students and the percent of white students. These two variables allow an investigation of equitable distribution of content and pedagogy.

Holding constant other variables in the equation, most notably Class Ability and School Ability, the Percent of White students in the class was a negative predictor of emphasis on Memorizing Facts and coverage of Precalculus content and a positive predictor of covering Geometry topics and emphasis upon solving Routine Problems and replicating experiments. On the other hand, minority students were more likely to experience Precalculus content in the courses they took than were white students, again controlling for Ability. In contrast, White students were more likely to experience Geometry content, though School Ability was a significant negative predictor of Geometry. Thus, our data suggest that math and science content are quite equitably distributed according to ethnicity.

Percent of Female students in the class was twice as often a significant predictor of content and pedagogy as Percent of White students in the class. Classes with relatively high percentages of Female students were less likely to have a teacher who emphasized Higher Order Thinking and problem solving, more likely to emphasize Routine Problems and replicating experiments, more likely to emphasize Memorizing Facts, and less likely to emphasize student Understanding. These findings, based on total questionnaire sample, apply to both mathematics and science instruction. Classes with high percentages of Female students were also less frequently Tested. Thus, there was some evidence to suggest modest inequality in distribution of content and pedagogy according to sex; the bias was against women.

Teacher Characteristics

The following teacher characteristics were entered as predictors in the regressions based on questionnaire data: Gender, Ethnicity, Education, Experience, Load, acceptance of Responsibility for student outcomes, and Satisfaction. For log sample regressions, only teacher Education and teacher Experience were teacher characteristics used as predictors.

Teacher Ethnicity was one of two teacher characteristics most predictive of classroom content and pedagogy. Minority teachers, in contrast to white teachers, placed more emphasis on Active student Learning and on Higher Order Thinking and problem solving. They also were more Demanding of their students and more likely to have Changed their instructional practices within the past three years. Seventy-seven percent of the teachers in the sample were white, 15 percent black, and 6 percent Hispanic. These findings favoring the instructional practices of minority teachers over majority teachers on a few key variables describing pedagogy and content are provocative. Those who argue that more minority teachers are desperately needed, especially in schools serving high concentrations of poor students, can find support of their contention in our work.

We also have supportive findings for teacher Education. Teachers who had more and more appropriate education for the subjects they were teaching placed greater emphasis on Higher Order Thinking and problem solving, Theory and Proof, used a greater fraction of instructional time for Academic purposes, were more likely to engage in Professional Reading, and Tested less frequently.

Our findings on teacher Experience were somewhat surprising. More experienced teachers in the math sample used a larger fraction of instructional time for Academic purposes than did less experienced teachers. In the science sample, more experienced teachers were less likely to use Drill as a pedagogical strategy than less experienced teachers. Thus, the only two findings for teacher Experience favored more experienced teachers.

Teacher Gender was not a significant predictor for any of the classroom content and pedagogical variables. Teachers with a relatively heavy Load and teachers who were more Satisfied were more Demanding of their students. Teachers who reported being high on Collegiality were more likely to emphasize Active Learning. Teachers who accepted Responsibility for student outcomes were more likely to emphasize Active Learning and Higher Order Thinking and problem solving. Apparently, teachers who meet more of the recommendations of the curriculum reforms of the late 1980s are also teachers who believe that student outcomes are a shared responsibility between themselves and their students.

Predicting Curriculum Reform Implementation

The curriculum reforms of the late 1980s and 1990s call for increased emphasis on higher order thinking and problem solving and instruction that involves more emphasis on students as active learners. For the questionnaire sample, the two best indicators of these curriculum reform characteristics are the variables Active Learning and HOT. Thus, it is useful to summarize here predictors of instruction most like that called for in reform.

The single strongest predictor of both indicators of reform was Subject matter. Science instruction placed more emphasis upon HOT and Active Learning than did mathematics. Importantly, the only other predictors of both variables concerned teachers. Teacher Responsibility was a positive predictor of Active Learning and HOT; thus, teachers who accept greater responsibility for student outcomes are more likely to emphasize higher order thinking and pedagogical strategies that draw on active learning. Teacher Ethnicity was also a significant predictor of both variables. Minority teachers were more likely to emphasize Active Learning and HOT than were majority teachers, at least in our schools serving high concentrations of low-achieving and minority students. Teacher Education was also a significant positive predictor of HOT. Teachers with better preparation for teaching their subject matter were more inclined to emphasize higher order thinking and problem solving than were less well-prepared teachers. Clearly, teachers are a key to implementing curriculum reform.

There was some indication that policy initiatives were having a reform-like effect as well. Group was a significant predictor of Active Learning. California and Arizona, states emphasizing active learning, had higher incidences of Active Learning than did states like South Carolina and

Florida, which were not emphasizing active learning. Course Level's negative relationship with Active Learning also might be interpreted as a policy effect. In curriculum reform at the high school level, greatest emphasis was being placed on lower level and beginning college prep courses. These are also the courses where we saw the highest incidence of active learning.

For HOT, class Ability was also a positive predictor. This finding suggests that reform must continue to press for equity.

Predicting School, Class, and Teacher Variables

Having considered the predictive value of school, class, and teacher variables on classroom content and pedagogy, it is useful to ask in turn, what, if anything, are the predictors of those school, class, and teacher characteristics.

Policy

The policy variables of this study were more predictive of teacher and school climate variables than they were direct predictors of classroom content and pedagogy. Group was a significant positive predictor of teacher Collegiality, teacher Satisfaction, and teacher Responsibility, and a significant negative predictor of teacher Control. Thus, California and Arizona, with their emphasis on higher order thinking and problem solving, had teachers that reported themselves more collegial, more satisfied, and more accepting of responsibility for student outcomes. In turn, teacher Responsibility was seen to be a positive predictor of emphasis upon Higher Order Thinking and Active Learning; teacher Satisfaction was a positive predictor of teacher Demands on students. Teacher Collegiality was not a significant predictor of any classroom content or pedagogical variables. Thus, to the direct effects seen for Group in predicting classroom content and pedagogy, one can add these indirect effects through teacher Responsibility and teacher Satisfaction.

The Policy scale was a significant predictor of all six school climate variables, having positive relationships with Leadership, Resources, Institutional Support, Shared Beliefs, and Teacher Collegiality, and a negative relationship with teacher Control. However, as already seen, school climate variables were not often significant predictors of classroom practices. Thus, the one direct effect of Policy on recent Change in classroom practice is not augmented much through indirect effects of school climate variables. Through its negative relationship with teacher Control, Policy appears to lead indirectly to a greater emphasis on facts and skills instruction. This is probably explained by the South Carolina and Florida sites, which were especially policy active and which emphasize basic skills, especially in mathematics.

Subject

Science teachers reported being in greater Control than did math teachers, which is consistent with mathematics being a much more regulated subject than science. Subject was also a positive predictor of Teacher Education, indicating that, at least for our sample, science teachers had more and more appropriate education for the subject they were teaching than did math teachers. Finally, math teachers were more likely to accept Responsibility for student outcomes than were science teachers. Thus, despite the fact that math teachers reported being less in control of their pedagogical practices, they were more willing to accept responsibility for student outcomes.

As already seen, Subject was one of the strongest direct predictors of classroom content and pedagogy. That science teachers were better educated for their subject than mathematics teachers were for theirs in no way explains away the positive results reported previously for teacher education; both subject matter and teacher education were independent predictors in those regressions predicting classroom practices.

Course Level

Course level was a positive predictor of teacher Control, Percent White students, and Teacher Education. Teachers of higher level courses tended to be better educated for the subject they were teaching and more in control of their content and pedagogy, and they were more likely to be teaching classrooms with higher percentages of white students. Also, teachers of higher level courses were less likely to report Sharing Beliefs with their colleagues and less likely to report strong Leadership in their school. These findings are consistent with our descriptions of state and district curriculum policy practices that found higher level courses less regulated than lower level courses. They also suggest teachers of higher level courses are perhaps a bit more independent in their approach to teaching than other teachers.

The finding that higher level courses have a higher percentage of white students is a bit troublesome, since school and class ability were controlled. Earlier, percent of white students in the class was not seen as a consistent predictor of quality of instruction or type of content received. Nevertheless, holding ability constant, apparently white students were more likely to be taking higher level courses than were minority students (standardized regression weight of .15).

School Ability, School Behavior, and Class Ability

Schools with higher ability and better behaved students are also schools with more resources and stronger leadership. Both School Ability and School Behavior were significant positive predictors of Leadership, Resources, and Institutional Support. They were also positive predictors of Shared Beliefs, but so also was Class Ability.

School Behavior and Class Ability were both independent positive predictors of teacher Responsibility, teacher Collegiality, and teacher Satisfaction, and for the math sample, teacher Control. Thus, the better behaved the students and the higher the ability of students in the class, the more likely the teachers were to be collegial, accept responsibility for student learning, be satisfied, and report being more in control of their instructional practices.

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APPENDIX A

DATA COLLECTION INSTRUMENTS

Daily Log Form
Weekly Questionnaire
PreLog Survey
Training Manual
Classroom Observation Scales
Classroom Observation Outline for Notes
Math/Science Teacher Interview Protocol
Department Chair Interview Protocol
Counselor Interview Protocol
Principal/Vice Principal Interview Protocol
Assistant Superintendent of Curriculum Interview Protocol
Math/Science Curriculum Specialist Interview Protocol
Director of Testing Interview Protocol
State Math or Science Coordinator of Curriculum Interview Protocol

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Teacher Name ____________________

School: ____________________

Date ____________________
month / day / year

DAILY LOG

1. Did all students study the same content? ___Yes ___No

If content coverage varied by student, describe content for a student near the class average.

2. How/many minutes of this class period were spent on activities not directly related to learning the academic content of this course? (e.g. announcements, attendance, establishing rapport, handling disruptions, etc.)

______ minutes

3. Describe the content taught/studied. If more than 5 types of content were covered, indicate the 5 that were most important.

EXAMPLE OR BRIEF DESCRIPTION OF CONTENT	CONTENT CODE*				EMPHASIS (Please circle)
	D_A	D_B	D_C	D_D	
					3 2 1
					3 2 1
					3 2 1
					3 2 1
					3 2 1

Content codes are found in content catalog.

Emphasis Scale: 3 = only content emphasized in the period (more than 50% of lesson)
2 = one of 2-4 types of content emphasized in the period
1 = important content, but not emphasized in this lesson (less than 20%)

*A content code is a four digit number determined by the four dimensional taxonomy of content.

4. What modes of instruction were used?

	EMPHASIS (Please circle)			
lecture	3	2	1	0
demonstration	3	2	1	0
recitation/drill	3	2	1	0
whole class discussion	3	2	1	0
students working in pairs/teams/small groups	3	2	1	0
students working independently	3	2	1	0

Emphasis Scale:
3 = only instructional mode emphasized (more than 50% of time)
2 = one of 2-6 modes emphasized
1 = used but less than 15% of the time
0 = not used

5. Indicate student activity.

	EMPHASIS (Please circle)			
listen/take notes	3	2	1	0
discuss/discovery lesson	3	2	1	0
complete written exercises/take a test	3	2	1	0
write report/paper	3	2	1	0
lab or field work	3	2	1	0
present/demonstrate	3	2	1	0

Emphasis Scale:
3 = primary student activity (more than 50% of time)
2 = one of 2-6 primary student activities
1 = less than 15% of student time
0 = not something students did today

6. Indicate instructional materials used (check all that apply).

___ primary text: indicate pages _________
___ primary workbook: indicate pages _________
___ supplementary texts
___ teacher-made assignment/exercises
___ lab/manipulatives/equipment (not computers or calculators)
___ computers
___ calculators
___ other material
___ test: ___ teacher made ___ other (check type) ___ (a) district or state developed
£ > Attach copy of test. ___ (b) publisher developed

7. Was homework assigned (check all that apply)?

___ No
___ Yes, reading assignment
___ Yes, exercises to complete that are corrected
___ Yes, exercises to complete, but aren't corrected
___ Yes, report/paper to write
___ Yes, other ________________________________

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WEEKLY QUESTIONNAIRE

Teacher Name_______________

School______________________________

Date______________________
(use Friday date for accompanying logs)

1. ADMINISTRATIVE ACTIVITIES:

STUDENTS ADDED TO COURSE: _____
# STUDENTS DROPPED FROM COURSE: _____

2. SPECIAL ACTIVITIES

Did you engage in any special activities this week, with this class, that were not adequately described in the daily logs?

____ No

____ Yes (Briefly describe activity and purposes.)

3. What, if any, professional activities did you participate in this past week that might relate to this course?

(a) conference/workshop
____No ____Yes (Describe on other side of sheet.)

(b) conversations/planning with colleagues
____No ____Yes (Describe on other side of sheet.)

(c) reading professional material (e.g., journal)
____No ____Yes (Describe on other side of sheet.)

(d) your instruction was observed or you observed someone else's instruction
____No ____Yes (Describe on other side of sheet.)

(e) other ____

4. Do you have any questions or suggestions for this study? If yes, call (608) 263-4354 or indicate below.

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PRELOG SURVEY

A. Please verify the following for your class (hereafter referred to as "target section") in our study (hopefully this information would be filled in by us)

1. Teacher name: ______________________________

2. District: __________________________________

3. School: ____________________________________

4. Course title: ______________________________

5. Period: ____________________________________

B. Please provide the following information:

1. How many sections of this course are being offered this semester (counting your section)? ______________

2. How many different teachers are teaching one or more section of this course this semester (counting you)? ________________

3. The majority of the students taking this course are following what track? (Check the most appropriate one.)

   ______ academic/college bound

   ______ vocational

   ______ general

   ______ none of the above track labels appropriately describe the majority of students taking this course

4. Are students assigned to sections on the basis of ability or prior achievement?

   ______ No (go to question 5)

   ______ Yes — a. How many ability levels are there? ______

   b. Indicate the ability level of your target section (1.0 indicates the highest ability level, 2.0 indicates next highest, etc.) ________

5. About which percentage of the students in your target section do you expect to

   a. stay in high school and graduate _____%

   b. graduate from college _____%

   c. take more than the required number of (mathematics or science) courses for high school graduation _____%

6. How many students are enrolled in the target section? _____

Complete the grid below as best you can.

	Female	Male
Black		
White		
Hispanic		
Native American		
Other		

7. Indicate the materials you plan to use.

A. primary text: Title
Author(s)
Publisher
Copyright date

B. primary workbook: Title
Author(s)
Publisher
Copyright date

other printed material

C. Title
Author(s)
Publisher
Copyright date

D. Title
Author(s)
Publisher
Copyright date

software

E. Title
Author(s)
Publisher
Copyright date

F. Title
Author(s)
Publisher
Copyright date

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DAILY LOG PROCEDURES

You are playing the most important role in the National Science Foundation funded Reform Up Close study. As a high school teacher of mathematics or science, keeping daily records of your instruction for one section of one course, you join 72 other teachers across six states (i.e., California, Florida, Pennsylvania, Missouri, South Carolina, and Arizona), twelve districts, and eighteen high schools. The information you supply about your instructional practices and your students will form the heart of a unique data base, describing math and science instruction in courses which have experienced large enrollment increases in recent years.

The purpose of this document is to describe procedures for completing the prelog survey, daily logs and weekly questionnaires. Before walking through that instrumentation, an overview of what we hope to learn from your reports may be helpful.

Purpose

The purpose of the daily logs and weekly questionnaires is to learn from you the content of your instruction and, to a lesser extent, the pedagogical practices used in delivering that instruction. Our focus on what is taught is relatively novel in research on teaching, and in research on education policies. Up until the last ten years or so, research on teaching focused on examination of pedagogical practices, typically without taking into account what was being taught. Research on education policies has typically stopped short of the classroom door. Thus, this study will provide new and important information.

No right or wrong answer. There are no right or wrong answers about what should be taught. There are, of course, many opinions, but they shift from time to time and reform to reform. Still, what is taught is, not surprisingly, one of the most powerful predictors of what students learn.

PreLog Survey

We ask that you complete the PreLog Survey now for the target course and section you will be keeping logs on, starting tomorrow. The information requested is, we hope, straightforward. There may, however, be information requested that you don't know. If that is the case, just write "don't know" in the space provided for your answer. Most of what we are interested in in this PreLog Survey is a characterization of your students and your instructional materials.

We will ask you to complete this PreLog Survey at the beginning of each semester (if you are on a semester system) that you participate in the study.

Weekly Questionnaire

There are two primary purposes of the weekly questionnaire. First, we know that the logs will not capture all of what you will feel is important about your instruction. Secondly, we would like to learn about activities in which you engage that may have bearing on your instruction.

Item 1 of the weekly questionnaire asks you to tell us about student turnover in your course. Please make an entry for each line, even if only a 0 or slash.

Item 2 of the weekly questionnaire asks you to report on "special activities" that may help us better understand the instructional context for your log content characterizations. Include any fieldtrips the class may have gone on in this item.

Item 3 of the weekly questionnaire asks you to describe activities that you participate in that could possibly relate to the course. Here we want you to be inclusive in your reporting. You don't need to be certain that an activity you report does relate to the particular course you are teaching. For example, any math or science workshop in which you participate should be reported, regardless of its focus.

Item 4 asks you to give us feedback, if you want, on how the study is going.

Weekly Questionnaires should be completed each Friday and mailed with that week's set of logs to the following address:

John Smithson, Wisconsin Center for Education Research, 1025 West Johnson
Street, Madison, WI 53706 (phone number: 608-263-4260).

Use the addressed and stamped envelopes provided. Also, if you have questions or confusions in completing the task, call John (collect) at the number given above.

Daily Logs

The daily log form consists of two sides of a single sheet of paper. The first side focuses on the content of your instruction; the second side focuses upon your pedagogical practices. As the name implies, this form is to be completed each time your target class meets. The form should be completed after the class meeting, so that it is a retrospective report on what occurred. These every-class-meeting records require no more than five to ten minutes to complete and should be done as soon after the class meeting as possible.

Non-Academic Activities. Item 2 asks for information on those activities not directly related to academic content. If students were involved in different activities, make your estimate based upon the average or typical student.

Content codes. The main task on the front side of the log sheet is completing Item 3. Here you are to provide brief descriptions of up to five types of content covered in a particular class session. Once you have provided a brief description and/or given examples on the left-hand side of item 3 for each type of content covered, you are to write in the content code, which is a four-digit number derived from the content code sheet that was provided to you. The following section on content descriptions provides more information on content coding, but for now refer to the content code sheet (Appendix B) as you read the following description.

Dimension A on the content code sheet identifies some general content areas. For example, a 0 on dimension A of the mathematics content code sheet refers to "numbers and number relations", whereas a 0 in dimension A of the science content code sheet identifies "biology of the cell".

Dimension B provides a further breakdown of these general categories, so that 04 (that is, 0-dim.A and 4-dim. B) would refer to "Fractions" for mathematics, and "Photosynthesis" for science. Math teachers should note here that "Fractions" appear in two places in dimension B - under "number and number relations" (0-dim. A) as well as under "arithmetic" (1-dim. A), the distinction here has to do with whether the students are learning about the general characteristics of fractions, or are doing arithmetic operations on fractions. Though there are no similar duplications on the science content code sheet, both science and math teachers should keep in mind that these various content areas are not intended to be course specific - you may well find that you cover a number of different categories listed under dimension A than the one most closely associated with your class.

Dimension C characterizes content according to the way in which it is presented. Unlike dimensions A and B, dimension C is identical for both math and science. Thus a "0" on dimension C would refer to exposition (whether verbal or written), while a "3" refers to equations or formulas, and a "5" to lab-work (see content code sheet).

Dimension D characterizes content according to the types/level of knowledge or skills that students are expected to acquire as a result of the activity. Dimension D begins with "memorizing facts/definitions/equations" (0), and ends with the relatively rare "build and revise theory/develop proofs" (8). Categories 4 and 5 are probably the most common categories of dimension D, since they include many types of skills through "performing procedures" (e.g. computational skills, classifying, etc.) or "solve routine problems" (such as a list of story problems involving similar solutions).

Thus, putting together these four dimensions yields a four-digit number/code that provides a fairly detailed description of the activity involved, as indicated by the examples provided in figures 1 and 2 following:

fig. 1 (math example)

EXAMPLE OR BRIEF DESCRIPTION OF CONTENT	CONTENT CODE*				EMPHASIS (Please circle)
	D_A	D_B	D_C	D_D	
Solving equations with integers Adding the opposite $x + -7 = -5$ $(x = 2)$	3	2	3	4	3 [✓ 2] 1
Review subtraction of integers $-7 - -10 = -7 + +10 = +3$	1	5	0	1	3 [✓ 2] 1
Solving equations with integers adding the opposite	3	2	3	1	3 [✓ 2] 1
					3 2 1
					3 2 1

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fig. 2 (science example)

EXAMPLE OR BRIEF DESCRIPTION OF CONTENT	CONTENT CODE*				EMPHASIS (Please circle)		
	D_A	D_B	D_C	D_D			
With concept map, review sexual/asexual cell reproduction	0	1	1	1	3	[✓ 2]	1
Model mitosis/meiosis with pipe cleaners	0	1	2	1	3	[✓ 2]	1
Review cell Function vocabulary	0	1	0	1	3	[✓ 2]	1
Vocabulary quiz on cell Function	0	1	0	0	3	[✓ 2]	1
					3	2	1

When providing brief descriptions, take care to have the descriptions provide information on each of the four dimensions of the taxonomy.

If you find you cannot decide upon the right numbered category of content for one or more of the four dimensions, either write in multiple numbers or, if you think it falls outside of the specific categories we have listed, put a question mark. Do your best to use our descriptors, even if you feel it requires a forced fit.

When math and science is not taught. Teachers have told us that in some of their most basic courses in mathematics and science, students require instruction in following directions and study skills. When instruction focuses on content other than math or science, write the description in the left-hand side of item 3, but when writing content codes, draw a line through Dimensions A and B and only code the content on Dimensions C and D. This will explain to us the nature of your instruction and ensure that it is counted, but not as math or science content.

Levels of emphasis. The final task in Item 3 is to circle one of three levels of emphasis for each content entry. There may be days in which a lesson covers only one cell of our taxonomy, and on that day you would write only one description, one content code, and circle a level 3 of emphasis. There may be other days in which you cover ten or more cells of the taxonomy. There you need to decide upon the five most important cells. Write brief descriptions for each, a four-digit content code for each, and circle the level of emphasis appropriate for each. If each type of content coded is equally important to each other, you would circle "2" for the level of emphasis for each. It may be that one topic was most important, and the others were less important but equally so, and then you would circle a level 3 for the most important topic and level "1s" for the others.

Getting used to the task. In the beginning, you may find describing your content difficult. But we have used similar procedures with teachers in a previous study, and can assure you that the task soon becomes straightforward and quickly completed. The procedure we recommend is to review in your mind what was taught and then, first, go to Dimensions A and B and decide on particular numbered categories of content there. Then, for each of those decide the appropriate numbered category of Dimension C. Finally, decide the appropriate numbered categories for Dimension D. Deciding levels of Dimension D will be the most difficult and should be done carefully.

Probably you will find that distinctions made in Dimensions C and D expand the number of types of content beyond the way you are used to thinking. Do not worry if you find that you covered more than five types of content, yet you are only reporting five. Also, if you find it difficult to decide upon which particular five to report, that probably means they were equally important, and any five will satisfy our requirements. We are not attempting to come up with accurate descriptions of each day of your instruction, but rather will report descriptions only in ways that summarize information across many days, at least a semester and probably a year.

Atypical Coding Examples

In trying out the daily log procedures with math and science teachers in the Madison public schools, we identified a few areas of likely confusion:

- When a movie is shown, there may be some confusion as to how to describe the pedagogical strategies, items 4 through 6. What you should do is respond according to the nature of the movie. For example, if it involves lecture, then code lecture; if it involves demonstration, code demonstration, even though it was in the movie, not something you were doing. Under instructional materials, check lab/manipulatives. For item 3, describing content, there may be confusion on Dimension C. If the movie involves going into the "field," code it as fieldwork, even though the students are only going into the field through watching the movie.
- When instruction involves a test, mark item 4 as "students working independently." Item 5 does include a option for test; so does item 6. When categorizing the content, item 3, the test typically covers many more topics than 5. Think about the main point of the test, and focus upon that content in deciding what to code.
- Some teachers use concept mapping when teaching math and science. If this is the case, Dimension C should be coded "pictorial model" and probably Dimension D will be coded "understand concepts."
- Several teachers have told us that they have their students read the text in class. If this is the case, item 5 should be checked "listen/take notes," even though that is a forced fit.

Describing pedagogical strategies. The second side of the daily log sheet contains Items 4 through 7. Item 4, oversimplified, asks you to describe what you were doing as a teacher. Item 5, oversimplified, asks you to describe what students were doing. Again, there are several options, and you are to mark each option, circling a 0 if it was not part of the lesson, and, again, one of three levels of emphasis if it was a part of the lesson.

Item 6 asks you to check each type of instructional material you used. In the case of textbooks, indicate the page numbers. In the case of tests that you made yourself, attach a copy. The last item, Number 7, asks about homework and, again, gives several options for you to check.

Content Descriptions

The need for a common language. Describing the content of instruction has a number of difficult problems that must be solved. First, a common language must be created so that each report of content coverage makes sense in its own terms, but also makes sense for forming comparisons across types of courses and types of students. We have created a four-dimensional taxonomy, one for math and one for science, to create such a language (see Table 1 for the mathematics taxonomy, Table 2 for the science taxonomy, and Appendix A for the mathematics and science content content code listings).

The taxonomy and how it works. The taxonomy allows content descriptions at a fairly detailed level by considering the intersection of all four dimensions A through D. For example, in math the content described by 0 of Dimension A, 0 of Dimension B, 0 of Dimension C, and 0 of Dimension D is instruction on sets/classification, using written or verbal exposition where students are to memorize facts/definitions/equations. Each cell in Table 1 or Table 2 describes a different type of math or science content. For example, Table 1 has 5,922 cells or specific types of mathematics content.

When describing instruction using either the science or math taxonomy, it is possible to have descriptions at the cell level, but more common to describe, for example, the relative emphasis on geometry (category 4 of Dimension A) or the relative emphasis upon work with equations/formulas (category 3 of Dimension C) or the relative emphasis upon collecting data (category 2 of Dimension D).

How the taxonomy was developed. These math and science taxonomies were developed specifically for this project. In deciding upon the dimensions and categories of the taxonomy, textbooks were consulted as well as reports from professional organizations such as the American Association for the Advancement of Science and the National Council of Teachers of Mathematics. Professors of mathematics, mathematics education, science, and science education at the University of Wisconsin-Madison and teachers in the Madison schools were also consulted. Taxonomies were drafted and reviewed by our National Advisory Committee for this project; substantial revisions were made. The National Advisory Committee involves a past president of the National Council of Teachers of Mathematics, science and math teachers from across the country, school district curriculum experts, and professors of math and science from universities across the country.

We recognize that the taxonomies fail to make important distinctions in some cases and may even leave out some important content you teach. Nevertheless, the dimensions and content categories are meant to be mutually exclusive and exhaustive in describing the mathematics or science content taught in United States high schools.

Conclusion

Undoubtedly the most challenging part of your participation in this study will be describing the content of your instruction. You should read through the science or math content codes repeatedly. Familiarize yourself with the categories of content under of each of the four dimensions A through D. Remember that a content description is not complete until it has been described by the appropriate numbered category of each of the four dimensions.

Examples for science and math are provided in Appendix A, and were obtained from teachers in the Madison, Wisconsin Public Schools. Study them now and ask questions for clarification.

Thank you for agreeing to participate in this most important part of this National Science Foundation study. Don't hesitate to call or write for clarification when you feel it is needed.

CPRE/RUC
11/8/89

TEACHER OBSERVATION

Note to Observer: Teacher observation forms have two parts. Part one is the Classroom Observation instrument that focuses on specific aspects of teacher and student behavior. Part II is the completion of the Teacher Log for each teacher observed. Record additional descriptive data right on these forms, e.g., use question 16 to report class activities. All data are extremely confidential and not to be shared with anyone outside the project staff.

Teacher Name____________________ Observer____________

Course Observed_________________ Period_________

School__________________________ Class Total_________

Date___________________________

Classroom Observation

When observing in the classroom focus on what the students are doing (time and type of engagement), level of questions the teacher is asking, type(s) of methods used by the teacher. **Complete a log on the classroom you finished observing and answer the following questions.**

1. Are different students working on different content during the class? YES NO Characterize the content differences.

Estimate student engagement in academic activity based on total class time:

% of class time engaged in academic task ___________

% procedural/waiting/teacher wasting students' academic time ______

% nonengaged, classwork finished or students off task_________

2. Number of same students attending to teacher or class activities most of the time:

1	2	3	4	5
More than 12 students inattentive	All but 7-12 students	All but 4-6 students	All but 1-3 students	All of the students

3. Teacher provides overview of the content and objectives of period's activities before beginning the activities:

1	2	3	4	5
No overview provided; begins activities immediately		Somewhat outlines		Clearly outlines content and objectives of the activities

4. Teacher explains how today's activities relate to previous lessons and the topic:

1	2	3	4	5
No link to previous lessons		Vague link to previous lessons		Explicit link to previous lessons

5. Teacher provides students with rationale for today's work:

1	2	3	4	5
Teacher never provides rationale		Teacher provides mostly mundane rationale		Teacher provides higher purpose rationale

6. Type of questions asked by teacher during recitation and demonstration:

1	2	3	4	5 [NA]
Mostly memory or fact questions questions		Mix of fact and comprehension		Mostly questions that require comprehension or opinion

7. Teacher allows students enough time to answer questions:

1	2	3	4	5 [NA]
Fast-paced; teacher allows less than 1/2 second		Moderate pace; teacher allows 1 second		Slower-paced; teacher allows 3 seconds or more

8. Teacher's feedback to academic student responses:

1	2	3	4	5 [NA]
None or mostly negative		Both negative and positive feedback		Mostly positive feedback

9. Teacher's efficiency in classroom management:

1	2	3	4	5 [NA]
Not efficient, many interruptions and delays, no system that works.		Moderate efficiency		Highly efficient, few interruptions and delays, a system that tells student what to do.

10. Teacher's effectiveness in handling discipline problems:

1	2	3	4	5 [NA]
Often does not see inappropriate or disruptive behavior		Catches wrong target or stops early; misbehavior after is spreads		Stops misbehavior initiates contacts before students get off-task

11. Teacher monitors students during seatwork and/or labwork:

1	2	3	4	5 [NA]
None of the time		About half of the time		All the time

12 Teacher's accessibility to individual students during seatwork and labwork:

1	2	3	4	5 [NA]
Avoids nearly all students who have requests	Helps only most persistent students who have requests	Helps some who have requests	Helps most students who have requests	Helps nearly all students who have requests

13. Teacher provides unsolicited feedback to individual students during seatwork and/or labwork:

1	2	3	4	5 [NA]
Teacher provides no unsolicited feedback		Teacher provides unsolicited feedback to about half the students		Teacher provides solicited feedback to nearly all students

14. Teacher paces period:

1	2	3	4	5 [NA]
Poorly; runs out of time or has too much time left; unevenly paced period				Well; accomplishes most of what s/he sets out to do; evenly paced period

15. Teacher summarizes important points and concepts at the end of the period:

1	2	3	4	5 [NA]
Not at all; period ends with no summary		Summarizes somewhat		Summarizes well highlights concepts at end period

16. Discuss any outstanding practice(s) you observed and/or explain your overall impression of the lesson.

CPRE/RUC
3/2/90

Classroom Observation

Note to researcher: The purpose of this protocol is to enhance data collected from the log you will complete during a class observation. The following is to serve as an outline for each classroom observation report.

Researcher____________________

Teacher____________________ School____________________

Date____________ Subject____________________ Section________

1. Complete log form, making comments in margins where additional information seems useful for clarification.

2. Describe the particular instructional activities in which students are engaged.

3. Are all kids studying the same content? If not, please describe the differences among students and differences in content.

4. Do students appear engaged in instructional activities? Is there an academically oriented productive environment?

5. To what extent does instruction engage students in actively constructing knowledge and solving problems (as opposed to students being passive learners)?

6. To what extent do students interact with each other about the subject matter?

7. What percent of the class period is actual instructional time? What are the activities during the non-instructional time (e.g., taking attendance, announcements, etc.)?

8. Characterize the students and their attitudes about the subject matter and the teacher.

9. Give a physical description of the classroom. Include descriptions of availability and quality of bulletin boards, teaching materials, lab equipment, supplementary aids, etc.

Center for Policy Research in Education

The questionnaire you are completing is to provide information on the impact of recent educational reforms on the content of _what_ is taught in math and science courses, and _how_ these courses are taught.

Your school is one of three schools from each of six states. In order to have complete data, we need a completed questionnaire from each science and math teacher in every school in the study. The information you provide in this questionnaire is an essential part of the study. Please be as complete and thorough as possible in completing the items included.

The questionnaire is divided into two parts. The first part asks the same things of all teachers. The second part pertains to a particular section of one of your science or math courses.

Please complete the section below. Then proceed to item one of the questionnaire.

Teacher Name____________________________ School Name____________________________

Department__________________________

Date____________________________

MATHEMATICS/SCIENCE TEACHER QUESTIONNAIRE
PART 1

1. What is your sex? (Circle One)

Male	1
Female	2

2. Which best describes you? (Circle One)

American Indian or Alaska Native	1
Asian or Pacific Islander	2
Hispanic, regardless of race	3
Black (not of Hispanic origin)	4
White (not of Hispanic origin)	5

3. Counting this year, how many years have you taught full time? ____ years
in this school district? ____ years
in this school? ____ years

4. At which of the following school levels have you taught?

(Circle all that apply)

Preschool	1
Elementary	2
Middle/junior high	3
Senior high	4
Postsecondary	5

5. Please mark the box(es) next to the degrees you hold. Use the list of code numbers on page 3 to indicate your major and minor fields of study for each degree. (If you do not have a second major or minor field, please enter "00".)

If you have not completed a degree, check -------- ☐ and skip to Question 7.

Degrees (Mark All That Apply)		Major Field Code	Second Major or Minor Field Code (If any)	Year of Degree
Bachelor's Degree..........................	☐	☐	☐	☐
2nd Bachelor's Degree..................	☐	☐	☐	☐
Master's Degree	☐	☐	☐	☐
2nd Master's Degree	☐	☐	☐	☐
Doctorate (e.g., Ph.D., Ed.D.)..........	☐	☐	☐	☐
First Professional Degree................ (e.g., M.D., L.L.B., J.D., D.D.S.)	☐	☐	☐	☐

6. Please indicate the college or university at which you received your bachelor's degree and the city and state in which the institution is located.

Name of Institution ____________________

City and State ____________________

7. In which subject areas do you have state teaching certification?

(Circle All That Apply)

Education	
Elementary education (please specify grades:)	01
Middle school education (please specify grades:)	02
Secondary education	03
Mathematics education	04
Science education	05
Other education	06
Science	
Biology, environmental, life sciences	11
Earth/space sciences	12
Physical sciences	13
Chemistry	14
Physics	15
Engineering	16
Mathematics/Computer Science	
Mathematics	21
Computer science	22
Other Disciplines	
Business	31
English, language arts, reading	32
Physical education, health	33
Social studies, history	34
Foreign language	35
Vocational education	36
Other (please specify)	37

8. Please list your teaching credentials/certificates: ______________________

____

____

9. Please indicate below the number of QUARTER or SEMESTER courses that you have taken at the undergraduate and graduate levels in the fields specified. **Please refer to your college transcript(s) if accessible. Estimate if you must.**

UNDERGRADUATE AND GRADUATE CREDIT HOURS

(Darken the circle that applies on each line)

	Quarter or Semester Courses					
	0-1	2-3	4-5	6-7	8-9	10 or more
a. Mathematics..	○	○	○	○	○	○
b. Mathematics education	○	○	○	○	○	○
c. Computer sciences...............................	○	○	○	○	○	○
d. Computer science education.................	○	○	○	○	○	○
e. Science	○	○	○	○	○	○
f. Science education................................	○	○	○	○	○	○

10. In what year did you last take a course *for college credit* or continuing education in math or science, or the teaching of math or science? ____________________

11. Which of the following subjects have you taught in the last three years?

If you have not taught mathematics or science in the last three years, check here ☐

MATHEMATICS **(Circle all that apply; then indicate level)**

		College Prep	Non-college Prep
Mathematics, grades 7-8	1	____	____
Remedial, business, consumer math	2	____	____
General math	3	____	____
Pre-algebra	4	____	____
Algebra, 1st year	5	____	____
Algebra, 2nd year	6	____	____
Geometry	7	____	____
Calculus	8	____	____
Advanced mathematics	9	____	____
Computer literacy, programming	10	____	____
Trigonometry	11	____	____
Probability	12	____	____
Statistics	13	____	____
Other: (2nd year courses or AP courses; please specify) ____________	14	____	____

SCIENCE

		College Prep	Non-college Prep
General Science	15	____	____
Biology, environment, life sciences	16	____	____
Chemistry	17	____	____
Physics	18	____	____
Physical science	19	____	____
Earth/space sciences	20	____	____
Other: (2nd year courses or AP courses; please specify) ____________	21	____	____

For 12 - 31 below, please use the scale provided to rate the extent to which you agree or disagree with the statements.

(Circle one on each line)

		Strongly Disagree					Strongly Agree
12.	Staff are involved in making decisions about what will be taught in their courses.	1	2	3	4	5	6
13.	My success or failure in teaching students is due primarily to factors beyond my control rather than to my own effort and ability.	1	2	3	4	5	6
14.	I sometimes feel it is a waste of time to try to do my best as a teacher.	1	2	3	4	5	6
15.	I usually look forward to each working day at this school.	1	2	3	4	5	6
16.	Teachers are not a very powerful influence on student achievement when all factors are considered.	1	2	3	4	5	6
17.	I am familiar with the content and specific goals of the courses taught by other teachers in my department.	1	2	3	4	5	6
18.	I make a conscious effort to coordinate the content of my courses with other teachers.	1	2	3	4	5	6
19.	In this school the mathematics/science curriculum is well-coordinated.	1	2	3	4	5	6
20.	Staff members in this school generally don't have much school spirit.	1	2	3	4	5	6
21.	Staff members maintain high standards of performance for themselves.	1	2	3	4	5	6
22.	The teachers in this school push the students pretty hard in their academic subjects.	1	2	3	4	5	6
23.	The school administration's behavior toward the staff is supportive and encouraging.	1	2	3	4	5	6
24.	Teachers participate in making most of the important educational decisions in this school.	1	2	3	4	5	6
25.	I receive a great deal of support from parents for the work I do.	1	2	3	4	5	6
26.	Necessary materials (e.g., textbooks, supplies, copy machine) are available as needed by the staff.	1	2	3	4	5	6
27.	The principal talks with me frequently about my instructional practices.	1	2	3	4	5	6

28.	Most of my colleagues share my beliefs and values about what the central mission of the school should be.	1	2	3	4	5	6
29.	The principal knows what kind of school he/she wants and has communicated it to the staff.	1	2	3	4	5	6
30.	There is a great deal of cooperative effort among staff members.	1	2	3	4	5	6
31.	Instructional resources at this school are inadequate for my needs.	1	2	3	4	5	6

32. At this school, how much actual influence do you think teachers have over the following?

(Circle one on each line)

	None					Complete Control
a) Determining the content of inservice programs	1	2	3	4	5	6
b) Setting policy on grouping students in classes by ability	1	2	3	4	5	6
c) Establishing curriculum	1	2	3	4	5	6
d) Deciding what students should take what courses	1	2	3	4	5	6
e) Determining discipline policy	1	2	3	4	5	6

33. How much control do you feel you have in your classroom over each of the following areas in your planning and teaching?

(Circle one on each line)

	None					Complete Control
a) Selecting textbooks and other instructional materials	1	2	3	4	5	6
b) Selecting content, topics, and skills to be taught	1	2	3	4	5	6
c) Selecting teaching techniques	1	2	3	4	5	6
d) Determining the amount of homework to be assigned	1	2	3	4	5	6
e) Setting standards for achievement in my classes	1	2	3	4	5	6
f) Disciplining students	1	2	3	4	5	6

34. How much of the time do you feel satisfied with your job in this school? **(Circle one)**

All of the time ____ 1
Most of the time ____ 2
Some of the time ____ 3
Almost never ____ 4

35. Since the beginning of last school year (1988-1989), how many half-days have you spent in formal inservice programs related directly to improving mathematics/science curriculum and instruction (e.g., professional conferences, workshops, or professional development)? Estimate if necessary.

(Circle one)

None ____ 1
1-2 half-days ____ 2
3-4 half-days ____ 3
5-6 half-days ____ 4
7-8 half-days ____ 5
More than 8 half-days ____ 6

36. What type(s) of support have you received?

(Circle all that apply)

None 1
Released time from teaching 2
Travel and/or per diem expenses 3
Stipends 4
Professional growth credits 5
Other *(please specify* ________________________*)* 6

37. Since the beginning of this school year, how much time per month (on average) have you spent meeting informally with other teachers on lesson planning, curriculum development, or other instructional matters?

(Circle one)

Less than 15 minutes ____ 1
15-29 minutes ____ 2
30-59 minutes ____ 3
1 hour or more, less than 5 ____ 4
5 hours or more, less than 10 ____ 5
10 hour s or more ____ 6

38. Since the beginning of the school year, how many times has your teaching been observed for purposes other than formal evaluation?

(Circle one)

Never	____ 1
Once	____ 2
Twice	____ 3
3-4 times	____ 4
5-9 times	____ 5
10 or more times	____ 6

39. During regular school hours, about how many hours per week do you have free for lesson planning and class preparation?

_____ hours/week

40. How many hours per week are you assigned to teach? _____hours/week

41. What is the total number of students you teach per day? _____students

42. How would you rate the average academic ability of students when they enter this school?

(Circle one)

Much above the national norm	_____1
Somewhat above the national norm	_____2
At the national norm	_____3
Somewhat below the national norm	_____4
Much below the national norm	_____5

43. About what percentage of the students in your classes are also in special education programs?

(Circle one)

None	_____1
Less than 10%	_____2
10% to 25%	_____3
26% to 50%	_____4
More than 50%	_____5

44. Indicate the degree to which each of the following matters are a problem with students in your school.

(Circle one on each line)

		Not a Problem	Minor	Moderate	Serious
a.	**Tardiness**	1	2	3	4
b.	**Absenteeism**	1	2	3	4
c.	**Class cutting**	1	2	3	4
d.	**Physical conflicts among students**	1	2	3	4
e.	**Gang activities**	1	2	3	4
f.	**Robbery or theft**	1	2	3	4
g.	**Vandalism**	1	2	3	4
h.	**Use of alcohol**	1	2	3	4
i.	**Use of other drugs**	1	2	3	4

45. **Since the beginning of the current school year, how many students' parents (or guardians) have you talked with individually regarding their child's classroom performance (not including contact at back-to-school night)?**

(Circle one)

None	______1
1-4 students' parents	______2
5-9 students' parents	______3
10-19 students' parents	______4
20-29 students' parents	______5
30 -39 students' parents	______6
40-59 students' parents	______7
60 or more students' parents	______8

46. The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does each of the following have?

(Circle one on each line)

	Positive Influence	Negative Influence	No Influence
a. Belief in the importance of mathematics/science when compared to other subject areas	1	2	3
b. Facilities	1	2	3
c. Funds for purchasing equipment and supplies	1	2	3
d. Materials for individualizing instruction	1	2	3
e. Numbers of textbooks	1	2	3
f. Quality of textbooks	1	2	3
g. Access to computers	1	2	3
h. Student interest in mathematics/science	1	2	3
i. Student reading abilities	1	2	3
j. Teacher interest in mathematics/science	1	2	3
k. Teacher preparation to teach mathematics/science	1	2	3
l. Student attendance	1	2	3
m. Teacher planning time	1	2	3
n. Time to teach mathematics/science	1	2	3
o. Class sizes	1	2	3
p. Student discipline	1	2	3
q. Articulation of instruction across grade levels	1	2	3
r. Diversity of mathematics/science electives	1	2	3
s. Enrollment in mathematics/science courses	1	2	3
t. District testing	1	2	3
u. Graduation requirements	1	2	3
v. Counselors	1	2	3

Center for Policy Research in Education

This part of the questionnaire pertains to a particular class period of one of the courses you teach. Your name, the name of the course, and the class period of your course are indicated below.

Please complete the other information requested below, then go on to the items in the questionnaire.

Teacher Name____________________________ Course/Period____________________

Department__________________________

School Name______________________

Date__________________________

Course-Specific Science Teacher Questionnaire
Part II

The following questions should be answered in reference to your ____________period ____________________ course.

47. How many students do you have in this class? ____students

48. Please indicate the number of students in this class in each race/sex category:

(Write all that apply on each line)

	Male	**Female**
White (not of Hispanic origin)	____________	____________
Black (not of Hispanic origin)	____________	____________
Hispanic..	____________	____________
American Indian or Alaskan Native	____________	____________
Asian or Pacific Islander	____________	____________
Other *(please specify____________________)*........	____________	____________
Total	____________	____________

Note: The total number of males and females should be the same as the number of students in Question 47.

49. In this class, how many students are:

Bilingual (English as a Second Language) ____________

LES (Limited English Speaking)/
LEP (Limited English Proficiency) ____________

50. How would you describe this class in terms of variation in student ability?

(Circle one)

Fairly homogeneous and low in ability....................1
Fairly homogeneous and average in ability.............2
Fairly homogeneous and high in ability..................3
Heterogeneous with a mixture of two
or more ability levels..4

51. In this class, what percentage of students do you estimate will be enrolled for virtually the entire course?

0 to 19% 1
20 to 39% 2
40 to 59% 3
60 to 79% 4
80 to 100% 5

52. Estimate the number of students who are repeating this course: ____________

53. Given the preparation and ability of students in this class, how would you characterize the overall level of student effort?

(Circle one)

Above expectations 1
About what you would expect 2
Below expectations 3

54. About how much classroom time do you spend on each of the following with this class during a typical week?

(Circle the closest number on each line)

	None	30 min.	1 hour	2 hours	3 or more hours
a. Lecturing to the class	1	2	3	4	5
b. Giving an oral recitation/drill	1	2	3	4	5
c. Whole class discussion	1	2	3	4	5
d. Students working in pairs/teams/small groups	1	2	3	4	5
e. Students working independently	1	2	3	4	5
f. Demonstration	1	2	3	4	5

55. About how much classroom time do students spend on each of the following activities for this class during a typical week?

(Circle the closest number on each line)

	None	30 min.	1 hour	2 hours	3 or more hours
a. Listening/taking notes	1	2	3	4	5
b. Engaged in discussion....................	1	2	3	4	5
c. Completing exercises/tests ..	1	2	3	4	5
d. Writing a report/paper......................	1	2	3	4	5
e. Doing lab or field work	1	2	3	4	5

56. How often do you do each of the following activities in this class?

(Circle one on each line)

	Every Day	Almost Every Day	Once a Week	Once a Month	Very Rarely
a. Go on field trips	1	2	3	4	5
b. Show films, filmstrips, or videotapes	1	2	3	4	5
c. Have students read supplementary materials	1	2	3	4	5

57. Consider the following types of content and the importance they play in this class. In column A we ask you to rank order them according to the importance you believe they play in this class. Enter a number from 1 to 5 in the space provided under "Rank Order." (1 = most important; 5 = least important). In column B we ask you to determine the percentage of time (relative to the other skills) you spend developing these abilities over the course of a semester.

	A Rank Order	B Percentage of Time
a. Memorize facts/definitions/equations	____	____
b. Understand concepts	____	____
c. Observe, measure, order, compare, classify	____	____
d. Solve routine problems, replicate experiments/proofs	____	____
e. Interpret data, recognize patterns, design experiments	____	____

58. Which best describes the availability of computers (microcomputers or terminals to mini/mainframe) for use with this science class?

		Not Available	Available But Difficult to Access	Readily Available
a.	Teacher demonstrations	____	____	____
b.	Student use in classrooms	____	____	____
c.	Student use in labs	____	____	____

59. How does this science class use computers and calculators?

If not used, check here ☐ and skip to Question 61.

(Circle all that apply)

	Computers	**Calculators**
Teacher demonstrating computer use	1	1
Writing programs	2	2
Learning science content	3	3
Laboratory tool	4	4
Drill and practice	5	5
Using simulations	6	6
Problem solving	7	7
Using computer graphics	8	8
Games	9	9
Testing and evaluation	10	10
Homework	11	11
Other *(please specify ________________)*	12	12

60. During the *last week* of instruction, how many minutes did a typical student spend working with computers and calculators as part of this science class?

(Circle one number in each column)

	Computers	**Calculators**
None	1	1
1-14 minutes	2	2
15-29 minutes	3	3
30-44 minutes	4	4
45-60 minutes	5	5
More than 60 minutes	6	6

61. Are you using one or more published textbooks or programs for teaching science to this class?

(Circle one)

Yes ....1 - *Go to Question 63*
No ....2 - *Go to Question 62*

62. Why did you choose not to use a textbook?

(Circle all that apply)

I prefer to teach without a textbook..1
I did not like the textbook assigned to this class.......................................2
Available textbooks were not appropriate for this class.............................3
There were insufficient funds to purchase textbooks 4
Other *(specify* ________________________________ 5
________________________________)

63. What is the primary text you used?

a. Title: ________________________________
b. Author /Publisher: ________________________________
c. Publication date: ________________________________

64. Approximately what percentage of the textbook will you "cover" in this course?

(Circle one)

Less than 25% 1
25-49%...2
50-74%...3
75-90%...4
More than 90%................................5

65. Indicate the persons or groups who helped determine that you would use this particular textbook in this science class.

(Circle all that apply)

I did..1
The principal..2
A group of teachers from this school 3
A district-wide textbook adoption committee..............................4
A state-wide textbook adoption committee 5
Other (*please specify* ________________________) 6

66. Please list any other materials that you used in your science class.

____

____

____

67. How much homework do you assign this class in a typical week?

	(Circle one)
0-30 min.	_____1
31-60 min.	_____2
61-90 min.	_____3
91-120 min.	_____4
2-3 hours	_____5
More than 3 hours	_____6

Questions 68 - 71. How often do you do the following with homework assignments?

(Circle one number on each line)

	Never	Some of the time	Most of the time	All of the time
68. Keep a record of who turned in assignments.	1	2	3	4
69. Return assignments with grades or corrections.	1	2	3	4
70. Discuss assignments in class.	1	2	3	4
71. Include homework grades when computing course grades.	1	2	3	4

72. What do you estimate will be the approximate distribution of final student grades in this class? (Total=100%)

(Write all that apply on each line)

A. ....__________%
B. ....__________%
C. ....__________%
D. ....__________%
F. ....__________%

TOTAL = 100%

73. Indicate the importance you give to each of the following grading criteria in setting grades for students in this class.

(Circle one on each line)

		Not important	Somewhat Important	Very Important	Extremely Important
a.	Absolute level of achievement	1	2	3	4
b.	Achievement relative to the rest of the class	1	2	3	4
c.	Individual improvement or progress over past performance	1	2	3	4
d.	Effort	1	2	3	4
e.	Class participation	1	2	3	4
f.	Completing homework assignments	1	2	3	4
g.	Consistently attending class	1	2	3	4

74. Below are three pairs of statements. Each pair of statements below represents opposite ends of a continuum in curriculum approaches. After reading a pair of statements (e.g., statements A and B under Pair #1), circle a position on the line between the statements indicating where you would place your approach (e.g., toward one end, the other, or somewhere in between).

Pair #1

A. My primary goal is to help students learn scientific terms and, formulas, and to master laboratory and computational skills.	/-/	B. My primary goal is to help students achieve a deeper understanding of key concepts and principles of science.

Pair #2

A. In my science course I aim for in-depth study of selected topics and issues, even if it means sacrificing coverage.	/-/	B. In my science course I aim for comprehensive coverage, even if it means sacrificing in-depth study.

Pair #3

A. My students generally learn basic scientific terms and formulas before learning underlying concepts and principles.	/-/	B. My students generally learn basic scientific terms and formulas while learning underlying concepts and principles.

Questions 75 and 76 are related. The first asks about your current emphasis on a variety of objectives under the regular conditions and constraints of teaching. The second asks for your views about the importance of the same objectives more abstractly.

75. In your science class, how much do you currently emphasize each of the following objectives:

(Circle one on each line)

	None	Minor Emphasis	Moderate Emphasis	Heavy Emphasis
a) Increase students' interest in science	1	2	3	4
b) Teach science facts and principles	1	2	3	4
c) Prepare students for further study in science	1	2	3	4
d) Develop problem solving/inquiry skills	1	2	3	4
e) Develop skill in laboratory techniques	1	2	3	4
f) Increase awareness of importance of science in daily life	1	2	3	4
g) Teach applications of mathematics in science	1	2	3	4
h) Teach applications of science in business and industry	1	2	3	4
i) Develop technical writing skills	1	2	3	4

76. In your science class, how much emphasis do you think each of the following objectives should receive:

(Circle one on each line)

	None	Minor Emphasis	Moderate Emphasis	Heavy Emphasis
a) Increase students' interest in science	1	2	3	4
b) Teach science facts and principles	1	2	3	4
c) Prepare students for further study in science	1	2	3	4
d) Develop problem solving/inquiry skills	1	2	3	4
e) Develop skill in laboratory techniques	1	2	3	4
f) Increase awareness of importance of science in daily life	1	2	3	4
g) Teach applications of mathematics in science	1	2	3	4
h) Teach applications of science in business and industry	1	2	3	4
i) Develop technical writing skills	1	2	3	4

77. Some education reports recommend that in science courses, students spend much more time learning the underlying logic of science, working on open-ended and real-world problems, and examining the reasoning behind certain scientific procedures. Compared with the way most courses are now, this recommendation could significantly reduce the number of different topics a course could cover and reduce emphasis on memorization of terms or formulas and routine computation. Do you think this would be a better or worse way to teach mathematics to your class?

	(Circle one)
Definitely better	______1
Probably better	______2
Not sure	______3
Probably worse	______4
Definitely worse	______5

78. Assume you agreed with the above recommendation; and assume you wanted to begin adopting this way of teaching science. Listed below (a-i) are propositions about potential obstacles you might encounter. For each proposition, circle the number rating your level of agreement about how much each would be an obstacle.

(Circle one one each line)

	Major Obstacle	Moderate Obstacle	Minor Obstacle	Not An Obstacle
a) Parents would object to this change.	1	2	3	4
b) Most students would not want to learn science this way.	1	2	3	4
c) Most students would be unable to learn effectively science this way.	1	2	3	4
d) I feel ill-prepared to teach science this way.	1	2	3	4
e) My classes are too large to teach science this way.	1	2	3	4
f) I do not have enough preparation time to teach science this way.	1	2	3	4
g) It would be very difficult to find text materials for teaching this way.	1	2	3	4
h) The time and activities required for preparing students for the state/district standardized test would prevent flexibility to teach this way.	1	2	3	4
i) I would be going against district curriculum goals and guidelines if I taught science this way.	1	2	3	4

79. Rate how big an influence (Major Influence to No Influence) each factor below has in determining the content (information, concepts, skills) of your science course.

(Circle one on each line)

	Major Influence	Moderate Influence	Minor Influence	No Influence
Guides and books				
a) State curriculum guides	1	2	3	4
b) District curriculum guides	1	2	3	4
c) Departmental decisions and guidelines	1	2	3	4
d) The main course textbook	1	2	3	4
Tests				
e) District tests	1	2	3	4
f) State tests	1	2	3	4
g) Department-wide tests	1	2	3	4
Individual decisions				
h) My own beliefs about what topics are important	1	2	3	4
i) My own knowledge of particular topics	1	2	3	4
j) What my students are capable of understanding	1	2	3	4
k) What my students need for future study and work	1	2	3	4
Administrators				
l) A principal or assistant principal	1	2	3	4
m) District curriculum specialist	1	2	3	4

80. Within the last three years, what changes have occurred in this course?

(Check Yes or No for each item)

POSSIBLE EFFECTS	Yes	No
a. Teaching students of lower ability	____	____
b. Teaching students of higher ability	____	____
c. Using different textbooks	____	____
d. Using different teaching methods	____	____
e. Revised course content to less difficult level	____	____
f. Revised course content to more difficult level	____	____
g. Altered sequences of topics	____	____

81. Using the scale provided, to what extent have the following changed during the last three years:

(Circle one on each line)

		Much Less			No Change		Much More	
a.	The amount of time devoted to nonteaching school activities or duties	1	2	3	4	5	6	7
b.	Agreement among professional staff on school goals	1	2	3	4	5	6	7
		Much Worse			No Change		Much Better	
c.	Your professional relationship with your principal or school head	1	2	3	4	5	6	7
d.	The general educational climate of the school	1	2	3	4	5	6	7
e.	The disciplinary climate of the school	1	2	3	4	5	6	7

82. Within the last three years, which of the following occurred at your school?

(Circle one on each line)

		Yes	No	Don't know
a.	Lengthening the school day	1	2	3
b.	Lengthening the school year	1	2	3
c.	Establishing a policy of increased homework	1	2	3
d.	Increased the number of advanced course offerings	1	2	3
e.	Increased graduation requirements in English, mathematics, science, social studies, computer science, or foreign languages	1	2	3
f.	Implemented competency testing for promotion or graduation	1	2	3
g.	Established new consistently enforced codes of student conduct	1	2	3
h.	Established a stricter attendance policy	1	2	3
i.	Established grade requirements for participation in athletics or extra-curricular activities	1	2	3

83. How would you compare the coverage of the above topics last year (88-89) with their coverage in similar classes you taught over the past 5 years?

	(Circle One)
Covered more before 88-89	1
Covered about the same each year	2
Covered less before 88-89	3
Don't know/didn't teach the class before	4

84. If you would like to discuss any changes that have occurred in the last three years in the topics covered in this class, please use the space below.

PLEASE COMPLETE THE TOPIC LIST ON THE FOLLOWING PAGE FOR THIS COURSE. THANK YOU

Item 85. The purpose of this item is to obtain a description of the content you cover in this course for the first half of this year (fall semester, if your school has semesters) Each of several content areas are listed. For each content area, you are asked to provid two types of information. The first is to indicate on a four-point scale the amount of time you estimate you will have spent on that content. The second scale asks you to indicate the depth of coverage of that content.

Be sure to consider each type of content on the list; the groupings of content are not meant to correspond to a particular course. Probably the content you cover in your course will be spread across many different parts of the list.

The depth of coverage scale will only be a crude approximation of what you do. The scale assumes that all instruction involves some memorization, but only instruction on content emphasized or covered at advanced levels involves building theory or developing proofs. The levels of the scale are, then:

1 Memorize facts/definitions/equations only
2 Solve routine problems, replicate experiments
3 Interpret data, solve novel problems, design experiments
4 Build and revise theory, develop proofs

For each content area you cover, indicate the highest level of coverage reached.

	Amount of Time Taught Circle one.)				Depth of Coverage (Circle highest level reached.)			
	Not Taught	less than 2 hrs.	2-10 hrs.	10+ hrs.	Memorize	Routine Problems	Novel Problems	Develop
BIOLOGY OF THE CELL								
0) Cell structure	0	1	2	3	1	2	3	4
1) Cell function	0	1	2	3	1	2	3	4
2) Transport of cellular material	0	1	2	3	1	2	3	4
3) Cell metabolism	0	1	2	3	1	2	3	4
4) Photosynthesis	0	1	2	3	1	2	3	4
5) Cell response	0	1	2	3	1	2	3	4
6) Genes	0	1	2	3	1	2	3	4
HUMAN BIOLOGY								
0) Nutrition	0	1	2	3	1	2	3	4
1) Digestive system	0	1	2	3	1	2	3	4
2) Circulatory system	0	1	2	3	1	2	3	4
3) Blood	0	1	2	3	1	2	3	4
4) Respiratory and urinary systems	0	1	2	3	1	2	3	4
5) Skeletal and muscular system	0	1	2	3	1	2	3	4
6) Nervous and endocrinic system	0	1	2	3	1	2	3	4
7) Reproduction	0	1	2	3	1	2	3	4
8) Human development/behavior	0	1	2	3	1	2	3	4
9) Health and disease	0	1	2	3	1	2	3	4

	Amount of Time Taught (Circle one.)				Depth of Coverage (Circle highest level reached.)			
	Not Taught	less than 2 hrs.	2-10 hrs.	10+ hrs.	Memorize	Routine Problems	Novel Problems	Develop
BIOLOGY OF OTHER ORGANISMS								
0) Diversity of life	0	1	2	3	1	2	3	4
1) Metabolism of the organism	0	1	2	3	1	2	3	4
2) Regulation of the organism	0	1	2	3	1	2	3	4
3) Coordination and behavior of the organism	0	1	2	3	1	2	3	4
4) Reproduction and development of plants	0	1	2	3	1	2	3	4
5) Reproduction and development of animals	0	1	2	3	1	2	3	4
6) Heredity	0	1	2	3	1	2	3	4
7) Biotechnology	0	1	2	3	1	2	3	4
BIOLOGY OF POPULATIONS								
0) Natural environment	0	1	2	3	1	2	3	4
1) Cycles in nature	0	1	2	3	1	2	3	4
2) Producers, consumers, decomposers: N_2, O_2, CO_2 cycles	0	1	2	3	1	2	3	4
3) Natural groups and their segregation	0	1	2	3	1	2	3	4
4) Population genetics	0	1	2	3	1	2	3	4
5) Evolution	0	1	2	3	1	2	3	4
6) Adaptation and variation in plants	0	1	2	3	1	2	3	4
7) Adaptation and variation in animals	0	1	2	3	1	2	3	4
8) Ecology	0	1	2	3	1	2	3	4
CHEMISTRY								
0) Periodic system	0	1	2	3	1	2	3	4
1) Bonding	0	1	2	3	1	2	3	4
2) Chemical properties and processes	0	1	2	3	1	2	3	4
3) Atomic and molecular structure	0	1	2	3	1	2	3	4
4) Energy relationships and equilibrium in chemical systems	0	1	2	3	1	2	3	4
5) Chemical reactions	0	1	2	3	1	2	3	4
6) Equilibrium	0	1	2	3	1	2	3	4
7) Organic chemistry	0	1	2	3	1	2	3	4
8) Nuclear chemistry	0	1	2	3	1	2	3	4
9) Environmental chemistry	0	1	2	3	1	2	3	4

	Amount of Time Taught (Circle one.)				Depth of Coverage (Circle highest level reached.)			
	Not Taught	less than 2 hrs.	2-10 hrs.	10+ hrs.	Memorize	Routine Problems	Novel Problems	Develop
PHYSICS								
0) Energy: sources and conservation	0	1	2	3	1	2	3	4
1) Heat (content & transfer)	0	1	2	3	1	2	3	4
2) Static and current electricity	0	1	2	3	1	2	3	4
3) Magnetism and electromagnetism	0	1	2	3	1	2	3	4
4) Sound	0	1	2	3	1	2	3	4
5) Light and spectra	0	1	2	3	1	2	3	4
6) Machines and mechanics	0	1	2	3	1	2	3	4
7) Properties and structures of matter	0	1	2	3	1	2	3	4
8) Molecular and nuclear physics	0	1	2	3	1	2	3	4
EARTH AND SPACE SCIENCE								
0) Physical geography	0	1	2	3	1	2	3	4
1) Soil science	0	1	2	3	1	2	3	4
2) Oceanography	0	1	2	3	1	2	3	4
3) Meterology	0	1	2	3	1	2	3	4
4) Geology	0	1	2	3	1	2	3	4
5) Earth's history	0	1	2	3	1	2	3	4
6) Solar system	0	1	2	3	1	2	3	4
7) Stellar system	0	1	2	3	1	2	3	4
8) Space explorations	0	1	2	3	1	2	3	4
GENERAL								
0) Nature and structure of science	0	1	2	3	1	2	3	4
1) Nature of scientific inquiry	0	1	2	3	1	2	3	4
2) History of science	0	1	2	3	1	2	3	4
3) Ethical issues in science	0	1	2	3	1	2	3	4
4) SI system of measurement	0	1	2	3	1	2	3	4
5) Science/technology and society	0	1	2	3	1	2	3	4

Teacher Name: ____________________

Home Address (for honorarium check) ____________________

____

____

Home Phone: ____________________

Social Security #: ____________________

Center for Policy Research in Education

This part of the questionnaire pertains to a particular class period of one of the courses you teach. Your name, the name of the course, and the class period of your course are indicated below.

Please complete the other information requested below, then go on to the items in the questionnaire.

Teacher Name____________________________ Course/Period___________________

Department__________________________

School Name_____________________

Date_________________________

Course-Specific Mathematics Teacher Questionnaire
Part II

The following questions should be answered in reference to your____________period ____________________ course.

47. How many students do you have in this class? ____students

48. Please indicate the number of students in this class in each race/sex category:

(Write all that apply on each line)

	Male	Female
White (not of Hispanic origin)	________	________
Black (not of Hispanic origin)	________	________
Hispanic	________	________
American Indian or Alaskan Native	________	________
Asian or Pacific Islander	________	________
Other *(please specify____________)*	________	________
Total	________	________

Note: The total number of males and females should be the same as the number of students in Question 47.

49. In this class, how many students are:

Bilingual (English as a Second Language) __________

LES (Limited English Speaking) / LEP (Limited English Proficiency) __________

50. How would you describe this class in terms of variation in student ability?

(Circle one)

Fairly homogeneous and low in ability	1
Fairly homogeneous and average in ability	2
Fairly homogeneous and high in ability	3
Heterogeneous with a mixture of two or more ability levels	4

51. In this class, what percentage of students do you estimate will be enrolled for virtually the entire course?

0 to 19% 1
20 to 39% 2
40 to 59% 3
60 to 79% 4
80 to 100% 5

52. Estimate the number of students who are repeating this course: ____________

53. Given the preparation and ability of students in this class, how would you characterize the overall level of student effort?

(Circle one)

Above expectations..1
About what you would expect..2
Below expectations..3

54. About how much classroom time do you spend on each of the following with this class during a typical week?

(Circle the closest number on each line)

	None	30 min.	1 hour	2 hours	3 or more hours
a. Lecturing to the class......................	1	2	3	4	5
b. Giving an oral recitation/drill..............	1	2	3	4	5
c. Whole class discussion...................	1	2	3	4	5
d. Students working in pairs/teams/small groups.................	1	2	3	4	5
e. Students working independently.....	1	2	3	4	5
f. Demonstration...............................	1	2	3	4	5

55. About how much classroom time do students spend on each of the following activities for this class during a typical week?

(Circle the closest number on each line)

	None	30 min.	1 hour	2 hours	3 or more hours
a. Listening/taking notes	1	2	3	4	5
b. Engaged in discussion....................	1	2	3	4	5
c. Completing exercises/tests ..	1	2	3	4	5
d. Writing a report/paper......................	1	2	3	4	5
e. Doing lab or field work	1	2	3	4	5

56. How often do you do each of the following activities in this class?

(Circle one on each line)

	Every Day	Almost Every Day	Once a Week	Once a Month	Very Rarely
a. Go on field trips	1	2	3	4	5
b. Show films, filmstrips, or videotapes	1	2	3	4	5
c. Have students read supplementary materials	1	2	3	4	5

57. Consider the following types of content and the importance they play in this class. In column A we ask you to rank order them according to the importance you believe they play in this class. Enter a number from 1 to 5 in the space provided under "Rank Order." (1 = most important; 5 = least important). In column B we ask you to determine the percentage of time (relative to the other skills) you spend developing these abilities over the course of a semester.

	A Rank Order	B Percentage of Time
a. Memorize facts/definitions/equations	____	____
b. Understand concepts	____	____
c. Observe, measure, order, compare, classify	____	____
d. Solve routine problems, replicate experiments/proofs	____	____
e. interpret data, recognize patterns, design experiments	____	____

58. Which best describes the availability of computers (microcomputers or terminals to mini/mainframe) for use with this math class?

		Not Available	Available But Difficult to Access	Readily Available
a.	Teacher demonstrations	___	___	___
b.	Student use in classrooms	___	___	___
c.	Student use in labs	___	___	___

59. How does this math class use computers and calculators?

If not used, check here ☐ and skip to Question 61.

(Circle all that apply)

	Computers	Calculators
Teacher demonstrating computer use	1	1
Writing programs	2	2
Learning math content	3	3
Laboratory tool	4	4
Drill and practice	5	5
Using simulations	6	6
Problem solving	7	7
Using computer graphics	8	8
Games	9	9
Testing and evaluation	10	10
Homework	11	11
Other *(please specify ________________)*	12	12

60. During the *last week* of instruction, how many minutes did a typical student spend working with computers and calculators as part of this math class?

(Circle one number in each column)

	Computers	Calculators
None	1	1
1-14 minutes	2	2
15-29 minutes	3	3
30-44 minutes	4	4
45-60 minutes	5	5
More than 60 minutes	6	6

61. Are you using one or more published textbooks or programs for teaching math to this class?

(Circle one)

Yes	1	- *Go to Question 63*
No	2	- *Go to Question 62*

62. Why did you choose not to use a textbook?

(Circle all that apply)

I prefer to teach without a textbook	1
I did not like the textbook assigned to this class	2
Available textbooks were not appropriate for this class	3
There were insufficient funds to purchase textbooks	4
Other *(specify* ______________________________ ______________________________)	5

63. What is the primary text you used?

a. Title: ______________________________

b. Author /Publisher: ______________________________

c. Publication date: ______________________________

64. Approximately what percentage of the textbook will you "cover" in this course?

(Circle one)

Less than 25%	1
25-49%	2
50-74%	3
75-90%	4
More than 90%	5

65. Indicate the persons or groups who helped determine that you would use this particular textbook in this mathematics class.

(Circle all that apply)

I did	1
The principal	2
A group of teachers from this school	3
A district-wide textbook adoption committee	4
A state-wide textbook adoption committee	5
Other (*please specify* ______________________________)	6

66. Please list any other materials that you used in your mathematics class.

____

____

____

67. How much homework do you assign this class in a typical week?

	(Circle one)
0-30 min.	______1
31-60 min.	______2
61-90 min.	______3
91-120 min.	______4
2-3 hours	______5
More than 3 hours	______6

Questions 68 - 71. How often do you do the following with homework assignments?

(Circle one number on each line)

	Never	Some of the time	Most of the time	All of the time
68. Keep a record of who turned in assignments.	1	2	3	4
69. Return assignments with grades or corrections.	1	2	3	4
70. Discuss assignments in class.	1	2	3	4
71. Include homework grades when computing course grades.	1	2	3	4

72. What do you estimate will be the approximate distribution of final student grades in this class? (Total=100%)

(Write all that apply on each line)

A. ....__________%
B. ....__________%
C. ....__________%
D. ....__________%
F. ....__________%

TOTAL = 100%

73. Indicate the importance you give to each of the following grading criteria in setting grades for students in this class.

(Circle one on each line)

		Not important	Somewhat important	Very important	Extremely important
a.	Absolute level of achievement	1	2	3	4
b.	Achievement relative to the rest of the class	1	2	3	4
c.	Individual improvement or progress over past performance	1	2	3	4
d.	Effort	1	2	3	4
e.	Class participation	1	2	3	4
f.	Completing homework assignments	1	2	3	4
g.	Consistently attending class	1	2	3	4

74. Below are three pairs of statements. Each pair of statements below represents opposite ends of a continuum in curriculum approaches. After reading a pair of statements (e.g., statements A and B under Pair #1), circle a position on the line between the statements indicating where you would place your approach (e.g., toward one end, the other, or somewhere in between).

Pair #1

A. My primary goal is to help students learn mathematical terms, master computational skills, and solve word problems.	/-/	B. My primary goal is to help students achieve a deeper conceptual understanding of mathematics.

Pair #2

A. In my mathematics course I aim for in-depth study of selected topics and issues, even if it means sacrificing coverage.	/-/	B. In my mathematics course I aim for comprehensive coverage, even if it means sacrificing in-depth study.

Pair #3

A. My students generally learn basic facts and computation skills before learning underlying principles of mathematics.	/-/	B. My students generally learn basic facts and skills while engaged in analytical exercises in mathematics.

Questions 75 and 76 are related. The first asks about your current emphasis on a variety of objectives under the regular conditions and constraints of teaching. The second asks for your views about the importance of the same objectives more abstractly.

75. In your mathematics class, how much do you currently emphasize each of the following objectives:

(Circle one on each line)

	None	Minor Emphasis	Moderate Emphasis	Heavy Emphasis
a) Increase students' interest in mathematics	1	2	3	4
b) Teach mathematics facts and principles	1	2	3	4
c) Prepare students for further study in math	1	2	3	4
d) Develop problem solving/inquiry skills	1	2	3	4
e) Develop skill in computational techniques	1	2	3	4
f) Increase awareness of importance of mathematics in daily life	1	2	3	4
g) Teach applications of mathematics in science	1	2	3	4
h) Teach applications of mathematics in business and industry	1	2	3	4
i) Develop technical writing skills	1	2	3	4

76. In your mathematics class, how much emphasis do you think each of the following objectives should receive:

(Circle one on each line)

	None	Minor Emphasis	Moderate Emphasis	Heavy Emphasis
a) Increase students' interest in mathematics	1	2	3	4
b) Teach mathematics facts and principles	1	2	3	4
c) Prepare students for further study in math	1	2	3	4
d) Develop problem solving/inquiry skills	1	2	3	4
e) Develop skill in computational techniques	1	2	3	4
f) Increase awareness of importance of mathematics in daily life	1	2	3	4
g) Teach applications of mathematics in science	1	2	3	4
h) Teach applications of mathematics in business and industry	1	2	3	4
i) Develop technical writing skills	1	2	3	4

77. Some education reports recommend that in math courses, students spend much more time learning the underlying logic of mathematics, working on open-ended and real-world problems in which the equation to use is not given, and examining the reasoning behind certain mathematical rules (e.g. why a non-zero number to the zero power is 1). Compared with the way most courses are now, this recommendation could significantly reduce the number of different topics a course could cover and reduce emphasis on computational drills and basic math. Do you think this would be a better or worse way to teach mathematics to your class?

(Circle one)

Definitely better	______1
Probably better	______2
Not sure	______3
Probably worse	______4
Definitely worse	______5

78. Assume you agreed with the above recommendation; and assume you wanted to begin adopting this way of teaching mathematics. Listed below (a-i) are propositions about potential obstacles you might encounter. For each proposition, circle the number rating your level of agreement about how much each would be an obstacle.

(Circle one one each line)

	Major Obstacle	Moderate Obstacle	Minor Obstacle	Not An Obstacle
a) Parents would object to this change.	1	2	3	4
b) Most students would not want to learn mathematics this way.	1	2	3	4
c) Most students would be unable to learn effectively mathematics this way.	1	2	3	4
d) I feel ill-prepared to teach mathematics this way.	1	2	3	4
e) My classes are too large to teach mathematics this way.	1	2	3	4
f) I do not have enough preparation time to teach mathematics this way.	1	2	3	4
g) It would be very difficult to find text materials for teaching this way.	1	2	3	4
h) The time and activities required for preparing students for the state/district standardized test would prevent flexibility to teach this way.	1	2	3	4
i) I would be going against district curriculum goals and guidelines if I taught mathematics this way.	1	2	3	4

79. Rate how big an influence (Major Influence to No Influence) each factor below has in determining the content (information, concepts, skills) of your mathematics course.

(Circle one on each line)

	Major Influence	Moderate Influence	Minor Influence	No Influence
Guides and books				
a) State curriculum guides	1	2	3	4
b) District curriculum guides	1	2	3	4
c) Departmental decisions and guidelines	1	2	3	4
d) The main course textbook	1	2	3	4
Tests				
e) District tests	1	2	3	4
f) State tests	1	2	3	4
g) Department-wide tests	1	2	3	4
Individual decisions				
h) My own beliefs about what topics are important	1	2	3	4
i) My own knowledge of particular topics	1	2	3	4
j) What my students are capable of understanding	1	2	3	4
k) What my students need for future study and work	1	2	3	4
Administrators				
l) A principal or assistant principal	1	2	3	4
m) District curriculum specialist	1	2	3	4

80. Within the last three years, what changes have occurred in this course?

(Check Yes or No for each item)

POSSIBLE EFFECTS	Yes	No
a. Teaching students of lower ability	____	____
b. Teaching students of higher ability	____	____
c. Using different textbooks	____	____
d. Using different teaching methods	____	____
e. Revised course content to less difficult level	____	____
f. Revised course content to more difficult level	____	____
g. Altered sequences of topics	____	____

81. Using the scale provided, to what extent have the following changed during the last three years:

(Circle one on each line)

		Much Less			No Change		Much More	
a.	The amount of time devoted to nonteaching school activities or duties	1	2	3	4	5	6	7
b.	Agreement among professional staff on school goals	1	2	3	4	5	6	7
		Much Worse			No Change		Much Better	
c.	Your professional relationship with your principal or school head	1	2	3	4	5	6	7
d.	The general educational climate of the school	1	2	3	4	5	6	7
e.	The disciplinary climate of the school	1	2	3	4	5	6	7

82. Within the last three years, which of the following occurred at your school?

(Circle one on each line)

		Yes	No	Don't know
a.	Lengthening the school day	1	2	3
b.	Lengthening the school year	1	2	3
c.	Establishing a policy of increased homework	1	2	3
d.	Increased the number of advanced course offerings	1	2	3
e.	Increased graduation requirements in English, mathematics, science, social studies, computer science, or foreign languages	1	2	3
f.	Implemented competency testing for promotion or graduation	1	2	3
g.	Established new consistently enforced codes of student conduct	1	2	3
h.	Established a stricter attendance policy	1	2	3
i.	Established grade requirements for participation in athletics or extra-curricular activities	1	2	3

83. How would you compare the coverage of the above topics last year (88-89) with their coverage in similar classes you taught over the past 5 years?

	(Circle One)
Covered more before 88-89	1
Covered about the same each year	2
Covered less before 88-89	3
Don't know/didn't teach the class before	4

84. If you would like to discuss any changes that have occurred in the last three years in the topics covered in this class, please use the space below.

PLEASE COMPLETE THE TOPIC LIST ON THE FOLLOWING PAGE FOR THIS COURSE. THANK YOU

Item 85. The purpose of this item is to obtain a description of the content you cover in this course for the first half of this year (fall semester, if your school has semesters). Each of several content areas are listed. For each content area, you are asked to provide two types of information. The first is to indicate on a four-point scale the amount of time you estimate you will have spent on that content. The second scale asks you to indicate the depth of coverage of that content.

Be sure to consider each type of content on the list; the groupings of content are not meant to correspond to a particular course. Probably the content you cover in your course will be spread across many different parts of the list.

The depth of coverage scale will only be a crude approximation of what you do. The scale assumes that all instruction involves some memorization, but only instruction on content emphasized or covered at advanced levels involves building theory or developing proofs. The levels of the scale are, then:

1 Memorize facts/definitions/equations only
2 Solve routine problems, replicate experiments
3 Interpret data, solve novel problems, design experiments
4 Build and revise theory, develop proofs

For each content area you cover, indicate the highest level of coverage reached.

	Amount of Time Taught (Circle one.)				Depth of Coverage (Circle highest level reached.)			
	Not Taught	less than 2 hrs.	2-10 hrs.	10+ hrs.	Memorize	Routine Problems	Novel Problems	Develop
NUMBER AND NUMBER RELATIONS								
0) Sets/classification	0	1	2	3	1	2	3	4
1) Whole number	0	1	2	3	1	2	3	4
2) Ratio/proportion	0	1	2	3	1	2	3	4
3) Percent	0	1	2	3	1	2	3	4
4) Fractions	0	1	2	3	1	2	3	4
5) Integers	0	1	2	3	1	2	3	4
6) Exponents	0	1	2	3	1	2	3	4
7) Decimals	0	1	2	3	1	2	3	4
8) Real numbers	0	1	2	3	1	2	3	4
9) Relations between numbers	0	1	2	3	1	2	3	4
ARITHMETIC								
0) Whole numbers	0	1	2	3	1	2	3	4
1) Ratio/proportion	0	1	2	3	1	2	3	4
2) Percent	0	1	2	3	1	2	3	4
3) Fractions	0	1	2	3	1	2	3	4
4) Integers	0	1	2	3	1	2	3	4
5) Decimals	0	1	2	3	1	2	3	4
6) Exponents	0	1	2	3	1	2	3	4
7) Radicals	0	1	2	3	1	2	3	4
8) Absolute value	0	1	2	3	1	2	3	4
9) Relationships between operations	0	1	2	3	1	2	3	4

	Amount of Time Taught (Circle one.)				Depth of Coverage (Circle highest level reached.)			
	Not Taught	less than 2 hrs.	2-10 hrs.	10+ hrs.	Memorize	Routine Problems	Novel Problems	Develop
MEASUREMENT								
0) Time	0	1	2	3	1	2	3	4
1) Length	0	1	2	3	1	2	3	4
2) Perimeter	0	1	2	3	1	2	3	4
3) Area	0	1	2	3	1	2	3	4
4) Volume	0	1	2	3	1	2	3	4
5) Angle	0	1	2	3	1	2	3	4
6) Weight	0	1	2	3	1	2	3	4
7) Mass	0	1	2	3	1	2	3	4
8) Rates	0	1	2	3	1	2	3	4
9) Relationships between measures	0	1	2	3	1	2	3	4
ALGEBRA								
0) Variable	0	1	2	3	1	2	3	4
1) Expressions	0	1	2	3	1	2	3	4
2) Linear equations or inequalities	0	1	2	3	1	2	3	4
3) Nonlinear equations or inequalities	0	1	2	3	1	2	3	4
4) Systems of equations or inequalities	0	1	2	3	1	2	3	4
5) Exponents or radicals	0	1	2	3	1	2	3	4
6) Sequences or series	0	1	2	3	1	2	3	4
7) Functions	0	1	2	3	1	2	3	4
8) Matrices	0	1	2	3	1	2	3	4
GEOMETRY								
0) Points, lines, segments, rays, angles	0	1	2	3	1	2	3	4
1) Relationship of lines, relationship of angles	0	1	2	3	1	2	3	4
2) Triangles and properties	0	1	2	3	1	2	3	4
3) Quadrilaterals and prop.	0	1	2	3	1	2	3	4
4) Similarity	0	1	2	3	1	2	3	4
5) Symmetry	0	1	2	3	1	2	3	4
6) Circles	0	1	2	3	1	2	3	4
7) Solid geometry	0	1	2	3	1	2	3	4
8) Coordinate geometry	0	1	2	3	1	2	3	4
9) Transformations	0	1	2	3	1	2	3	4

	Amount of Time Taught (Circle one.)				Depth of Coverage (Circle highest level reached.)			
	Not Taught	less than 2 hrs.	2-10 hrs.	10+ hrs.	Memorize	Routine Problems	Novel Problems	Develop
TRIGONOMETRY								
0) Trigonometric ratios	0	1	2	3	1	2	3	4
1) Basic identities	0	1	2	3	1	2	3	4
2) Pythagorean identities	0	1	2	3	1	2	3	4
3) Solu. of right triangles	0	1	2	3	1	2	3	4
4) Solu. of other triangles	0	1	2	3	1	2	3	4
5) Trigonometric functions	0	1	2	3	1	2	3	4
6) Periodicity, amplitude,...	0	1	2	3	1	2	3	4
7) Polar coordinates	0	1	2	3	1	2	3	4
STATISTICS								
0) Collecting data	0	1	2	3	1	2	3	4
1) Distributional shapes	0	1	2	3	1	2	3	4
2) Central tendency	0	1	2	3	1	2	3	4
3) Variability	0	1	2	3	1	2	3	4
4) Correlation or regression	0	1	2	3	1	2	3	4
5) Sampling	0	1	2	3	1	2	3	4
6) Estimating parameters - (point est.)	0	1	2	3	1	2	3	4
7) Estimating parameters - confidence intervals	0	1	2	3	1	2	3	4
8) Hypothesis testing	0	1	2	3	1	2	3	4
PROBABILITY								
0) Events, possible outcomes, trees	0	1	2	3	1	2	3	4
1) Equally likely - relative frequency prob.	0	1	2	3	1	2	3	4
2) Empirical probability	0	1	2	3	1	2	3	4
3) Simple counting schemes	0	1	2	3	1	2	3	4
4) Conditional probability	0	1	2	3	1	2	3	4
5) Discrete distributions - binomial	0	1	2	3	1	2	3	4
6) Discrete distributions - other	0	1	2	3	1	2	3	4
7) Continuous distributions - normal	0	1	2	3	1	2	3	4
8) Continuous distributions - other	0	1	2	3	1	2	3	4

	Amount of Time Taught (Circle one.)				Depth of Coverage (Circle highest level reached.)			
	Not Taught	less than 2 hrs.	2-10 hrs.	10+ hrs.	Memorize	Routine Problems	Novel Problems	Develop
ADVANCED ALGEBRA/ PRECALCULUS/CALCULUS								
0) Functional notation and properties	0	1	2	3	1	2	3	4
1) Operations with functions	0	1	2	3	1	2	3	4
2) Polynomial functions	0	1	2	3	1	2	3	4
3) Exponential functions	0	1	2	3	1	2	3	4
4) Logarithmic functions	0	1	2	3	1	2	3	4
5) Relations between types of functions	0	1	2	3	1	2	3	4
6) Matrix algebra	0	1	2	3	1	2	3	4
7) Limits and continuity	0	1	2	3	1	2	3	4
8) Differentiation	0	1	2	3	1	2	3	4
9) Integration	0	1	2	3	1	2	3	4
FINITE/DISCRETE MATHEMATICS								
0) Sets	0	1	2	3	1	2	3	4
1) Logic	0	1	2	3	1	2	3	4
2) Business math	0	1	2	3	1	2	3	4
3) Linear programming	0	1	2	3	1	2	3	4
4) Networks	0	1	2	3	1	2	3	4
5) Iteration and recursion	0	1	2	3	1	2	3	4
6) Markov chains	0	1	2	3	1	2	3	4
7) Development of computer algorithms	0	1	2	3	1	2	3	4
8) Mathematical modeling	0	1	2	3	1	2	3	4

SCHOOL LEVEL INTERVIEWS

MATH/SCIENCE TEACHER INTERVIEW PROTOCOL*[1]

[Introduction: I am part of a research team from the University of Wisconsin-Madison. We are doing a study of how recent policies to reform education have influenced math and science in your district and schools. I'd like to ask you some questions about ways these changes have affected ______________(district) and ______________(schools, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?]

Any information you provide will be available only to our research team an no one in your district or school will know what you say. Because I can't record your ideas fast enough with pencil and paper, I'd like to record our conversation, but won't do that unless you agree. Is it okay?

1. What do you emphasize in this course?

LOW 2. What are your primary instructional materials?

Probes:

Textbook/lab manual?

3. Describe the text.

Probes:

Emphasis?

Strengths?

Weaknesses?

Appropriate for the level of students in this class?

Researcher's use only:

1	2	3	4	5
Not Appropriate				Very Appropriate

---

[1] Researcher: Use of "High," "Medium" or "Low" in left hand margin indicates question priority. If time is limited, be certain to include "high" questions.

4. Do you follow the text?

Probes:

Omissions?

Additions?

5. There is a good deal of talk these days about issues like "scientific literacy" or "math literacy." In your opinion, what does it mean to be scientifically or mathematically "literate?" Give an example.

6. How do students get into this class?

Probes:

Are they tracked?

What is the role of teachers in student placement?

Where do they go after this class?

7. Are there prerequisites for this class? If yes, what are they?

8. Are there individual differences between the students that you take into account when teaching this class?

Researcher's use only:

1	2	3	4	5
None				Many

9. How are teachers at this school assigned to this course? (Probe for the amount of freedom teachers have to choose their classes or refuse an assignment).

10. a. How many years have you been teaching this course?

Researcher's use only:

0-2	3-5	5-7	7-9	10+
1	2	3	4	5

b. What different subjects have you taught?

c. Have you participated in professional activities such as workshops, inservices, that enhance your effectiveness as a math/science teacher? In what ways?

d. Do you feel you have the subject matter background and training necessary to teach this course? Why or why not?

11. What special strengths are needed to teach this course?

12. What types of training programs are provided by the school or the district for teachers who want to improve their knowledge of the content or of teaching techniques such as a Biology teacher who begins teaching Algebra?

13. For your course, how do you decide what to teach?

HIGH

Probes:

State frameworks
District guides
National, state, or district tests
Textbook or laboratory manual
Staff development or inservice activities
Continuing education classes
Professional Journals
Colleagues, departmental decisions
Students
Principal
Parents of your students
Graduation requirements

14. For your course, how do you decide what teaching strategies to use with the students in your class? Focus on recent changes.

HIGH

Probes:

State frameworks
District guides
National, state, or district tests
Textbook or laboratory manual
Continuing education classes
Professional Journals
Staff development or inservice activities
Colleagues, departmental decision
Students
Principal

15. In what ways, if any, have policy directions from national organizations such as NCTM, AFT, or NSTA influenced what you teach?

Researcher's use only:

1	2	3	4	5
No Influence				Major Influence

16. Are you able to do what you'd like with this course?

    a. If not, and there were no constraints, what would you do differently?

    b. What are the obstacles to doing what you'd like with this course?

HIGH

17. How are instructional materials allocated at your school?

    a. Are resources divided by teacher or by department?

    b. Are the instructional materials adequate for teaching your course?

    c. Are lab facilities adequate for teaching your course?

    d. In the best of all worlds, what additional supplies and equipment would you like to have available?

HIGH

18. Over the last few years, have changes in district and state policies, mandates, and procedures influenced math/science at your school? If yes, how have math and science changed?

Probes:

Has your teaching changed?

Did the characteristics of your students change?

Has the addition of basic level courses led to changes in higher level courses? If so, describe these changes.

Have your class assignments changed?

19. In what ways, if any, have changes in policy influenced your feelings about teaching?

DEPARTMENT CHAIR INTERVIEW PROTOCOL*[1]

[Introduction: I am part of a research team from the University of Wisconsin-Madison. We are doing a study of how recent policies to reform education have influenced math and science in your district and schools. I'd like to ask you some questions about ways these changes have affected ______________(district) and ______________(schools, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?

Any information you provide will be available only to our research team an no one in your district or school will know what you say. Because I can't record your ideas fast enough with pencil and paper, I'd like to record our conversation, but won't do that unless you agree. Is it okay?]

1. Tell me a little about your role as a department chair.
    a. What are your responsibilities?
    b. Describe your typical day.
    c. Are you compensated for being department chair? If yes, how?
2. How long have you been at this school?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+ yrs

3. How long have you been in this district?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+ yrs

---

[1] Researcher: Use of "High," "Medium" or "Low" in left hand margin indicates question priority. If time is limited, be certain to include "high" questions.

4. Now I'd like to ask you some questions about the overall administration of the science/math department:

a. How many teachers in your department?

Researcher's use only:

0-5	6-11	11-21	21-31	31+
1	2	3	4	5

b. How often does the science/math department have meetings?

Researcher's use only:

Weekly	Twice/month	Monthly	Once/semester	Once/year
1	2	3	4	5

c. What functions do these meetings serve?

d. Describe your last meeting, its purpose.

e. Decisions?

f. When did this meeting take place?

5. Are there resource people, such as paid instructional aides, who work for the science/math department? If so, what are their responsibilities?

6. How do students select courses? Give an example.

7. Describe the role of prerequisites (i.e., math or science) in students' course choices.

8. Are there specific tracks (pathways/sequences) that students can take in science and math? **(If not, go to Question 9).** How do you refer to these at your school? **(In the following questions, use department chair's term for track or sequence).**

a. Goals? How do goals differ from track to track?

b. For what type of student is each track intended?

c. What criteria are used to determine students' track?

d. What is the role of counselors in student placement?

e. What is the role of teachers in student placement?

f. What is role of the administration, either at the school or the district level, in determining student placement?

g. If I'm a student in the "middle" track **(use department chair's terminology)**, how much choice do I have about the classes I take? Can I take a class on a different track? Why or why not? Is this true of higher or lower tracks in science? Is this true of higher or lower tracks in math? Is this true of tracks in other subject areas?

h. If students are in the low track in science, are they likely to be in the same track in math? What about English? Is there a relationship between different tracks at your school?

(GO TO QUESTION 10)

9. If your school does not have tracks/pathways/sequences: **(use department chair's terminology)**

a. Are there still certain sequences of courses that students should take?

b. How do the students know which courses to take? Give an example.

c. What is the role of the counselors in student placement?

d. What is the role of teachers in student placement?

e. What is the role of the administration, either at the school or district level, in determining student placement?

f. If I'm an average student without much interest in science and/or math, what courses should I take? What if I'm a below-average student? What if I'm an advanced student?

10. How are teachers at this school assigned to classes?

Probes:

Can teachers choose? True in other schools?

Seniority play a role? True of other schools?

Other criteria?

a. How are new teachers placed?

b. Do you feel the teachers in your department have the subject matter background and training necessary to teach their classes? Why or why not?

HIGH

Researcher's use only:

1	2	3	4	5
None	Some	Average	Above Average	Strong

11. Does your department have a shortage of qualified teachers? If so, what is being done to alleviate the problem of shortages of science/math teachers?

a. Are the steps you just described sufficient? If not, what further steps would you like to see taken?

b. Are training programs provided by the school or the district for teachers who want to improve their knowledge of the content or of teaching techniques?

12. At your school, how are decisions about the science/math curricula made?

HIGH

a. Who decides which courses will be offered?

b. Who decides what content will be covered?

c. Are the teachers provided with curriculum guides? If so, by whom were these developed?

d. Who decides what textbooks will be used?

e. Who makes decisions regarding additional teaching materials?

f. What influence does the science and math departments have on curriculum decisions? What about the district?

13. How do administrators determine if course objectives are met?

a. Are teachers observed?

b. If yes, how often and what is the purpose?

c. Is there a standard district form for evaluating teachers? **(If yes, get document.)**

14. Describe the testing that occurs to meet school and district requirements.

15. Over the last few years, have changes in district and state policies in the area of science/math education influenced your school?

HIGH

a. Has your job changed as a result of these changes?

b. Have these policies affected teachers in this school?

Probes:

How teachers teach?

What they teach?

Feelings, morale of teachers?

c. What classes were added as a result of these changes in policy?

d. What classes were deleted as a result of these changes in policy?

16. If you had to identify the person who knows the most about changes in the courses offered in this department since 1980, who would it be?

Probes:

Name
Phone

17. Has the addition of basic level courses led to changes in higher level courses? If so, describe these changes.

18. Have changes affected teacher assignments to classes? If yes, please explain.

19. Have changes led to differences in student movement from track to track? If yes, please explain.

a. What ways, if any, are provided for students to "cross over" from one track to another?

b. How does your school support or discourage cross-over?

c. What internal or external policy factors promote or inhibit cross-over?

d. How often do students cross over to another track?

e. If crossing over does occur, is it more typical for a student to go up to a higher-level course, or drop down to a lower-level course?

20. Have added science/math requirements at your school influenced student achievement or interest in the subject(s)?

Probes:

Students taking more electives?

Students showing more interest in science/math club or other science/math-related activities?

21. Have there been any changes in test taking patterns or scores?

Probes:

District-level tests?

22. What do you believe are the strengths of your science/math program? Examples?

23. What do you believe are the weaknesses of your science/math program? Examples?

24. Generally speaking, are you able to conduct your work as department chair as you would like to?

a. If not, what would you like to see changed?

COUNSELOR INTERVIEW PROTOCOL*[1]

[Introduction: I am part of a research team from the University of Wisconsin-Madison. We are doing a study of how recent policies to reform education have influenced math and science in your district and schools. I'd like to ask you some questions about ways these changes have affected ______________(district) and ______________(schools, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?

Any information you provide will be available only to our research team an no one in your district or school will know what you say. Because I can't record your ideas fast enough with pencil and paper, I'd like to record our conversation, but won't do that unless you agree. Is it okay?]

1. Tell me about your work as a counselor.
    - a. How do you spend most of your time? Give an example of a typical day.
    - b. How many students do you advise?
    - c. How often do you meet with your advisees?

2. How long have you been at this school?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

3. Have you been a teacher? Have you taught at this school?

HIGH 4. How do you advise students in the areas of science and math?
    - a. Do you advise them about the selection of particular courses in math and science?

---

[1] Researcher: Use of "High," "Medium" or "Low" in left hand margin indicates question priority. If time is limited, be certain to include "high" questions.

b. What determines your advice, e.g., student abilities, tracks, state requirements, etc.?

c. Do you talk about college requirements?

d. Do you talk about careers in math and science?

5. Characterize the students at this school. **(Probe for student SES, ability, interest in math and science, etc.)**

Researcher's use only:

	Low	Low-Middle	Middle	Upper-Middle	High
SES	1	2	3	4	5
STUDENT ABILITY	1	2	3	4	5
INTEREST	1	2	3	4	5

6. How do students select courses?

HIGH

7. What factors do you think affects students' choices about which courses to take?

HIGH

8. Do prerequisites (i.e., math or science) have a role in students' course choices.

9. Are there specific tracks (pathways/sequences) that students can take in science and math? **(If not, go to Question 15).** How do you refer to these at your school? **(In the following questions, use counselor's term for track or sequence. Ask the informant for copies of any documentation describing tracks or course sequences).**

HIGH

10. What types of students are included in this track?

Researcher's use only:

Low	Low-Middle	Middle	Upper-Middle	High
1	2	3	4	5

a. What are the goals of this track?

b. What percentage of the student body is in this track?

Researcher's use only:

1	2	3	4	5
0-15%	16-25%	26-50%	51-75%	76-100%

c. What is the recommended course sequence for students in this track?

d. How many sections are there of each course in the sequence?

11. What differences, if any, are there between different sections or tracks of the same course?

a. How does biology **(or other course title)** in the lower track, for example, differ from biology **(or other course title)** in the upper track?

b. If I'm a student in the "middle" track **(use counselor's terminology)**, how much choice do I have about the classes I take? Can I take a class on a different track? Why or why not? Is this true of higher or lower tracks in science? Is this true of higher or lower tracks in math? Is this true of tracks in other subject areas?

c. If a student is in the _________ track in science, what is the likelihood that he or she is in the same track in math? What about English? What is the relationship between different tracks at your school?

d. If I'm a new student, or a transfer student, how would I get placed?

12. What special needs of students are met with the current tracking procedure?

HIGH

13. What criteria are used for determining into which track a student will be placed?

a. When are the decisions made?

b. Role of counselors?

c. Role of teachers?

d. Role of parents?

e. Role of the administration, either at the school or the district level, in determining student placement?

14. Do you feel the system works well? Why or why not?

15. If your school does not have tracks/pathways/sequences **(use counselor's terminology)**, how do you deal with students who have different interests or abilities?

HIGH

a. How do the students know which courses to take?

b. What is the role of the counselors in student placement?

c. What is the role of teachers in student placement?

d. What is the role of the administration, either at the school or district level, in determining student placement?

e. If I'm an average student without much interest in science and/or math, what courses should I take? What if I'm a below-average student? What if I'm an advanced student?

16. Generally speaking, are you able to conduct your work as a counselor as you would like?

HIGH

a. If not, what would you like to see changed?

PRINCIPAL/VICE PRINCIPAL INTERVIEW PROTOCOL*[1]

[Introduction: I am part of a research team from the University of Wisconsin-Madison. We are doing a study of how recent policies to reform education have influenced math and science in your district and schools. I'd like to ask you some questions about ways these changes have affected ______________(district) and ______________(schools, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?]

Any information you provide will be available only to our research team an no one in your district or school will know what you say. Because I can't record your ideas fast enough with pencil and paper, I'd like to record our conversation, but won't do that unless you agree. Is it okay?

1. What are your responsibilities?

2. How long have you been a principal at this school?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	6-8 yrs	9-11yrs	11+yrs

3. How long have you been in this district?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	6-8 yrs	9-11yrs	11+yrs

4. What other positions have you held:

5. Please describe the science/math curriculum at this school.

6. At your school, how are decisions about the science and math curricula made?

    a. Who decides which courses will be offered?

    b. Who decides what content will be covered?

    c. Are the teachers provided with curriculum guides? If so, by whom were these developed?

    d. Who decides what textbooks will be used?

---

[1] Researcher: Use of "High," "Medium" or "Low" in left hand margin indicates question priority. If time is limited, be certain to include "high" questions.

e. Who makes decisions regarding additional teaching materials?

f. What influence do the science and math departments have on curriculum decisions? What about the district?

7. Do administrators evaluate whether course objectives are met? If yes, how?

HIGH

a. Teachers observed teaching?

b. An evaluation form?

c. Lesson plans required?

8. Describe the testing program that meets school and district requirements.

9. Science and math education is getting a lot of attention in the national media, from professional associations, and from politicians recently. Have these conversations influenced science and math instruction at your school?

10. How does this school support math and science instruction at this school? Give example.

11. Do district-level administrators support math and science instruction at this school? If yes, how?

12. How are resources for instructional materials allocated at your school?

HIGH

a. Do you feel there are sufficient funds available for buying supplies and equipment?

b. How does your level of resources compare with the other schools in the district?

c. On what do you spend your funds?

d. Are there important shortages?

If yes, what do these shortages prevent you from doing?

Are you taking steps to remedy the problem?

13. Please describe any important changes in the area of science and math education in the last 10 years.
HIGH

Probe:

Content

Standards

Coursetaking

14. What brought about these changes?
HIGH

Probes:

State frameworks?

District guidelines?

National, state, or district tests?

Textbooks or laboratory manuals?

Staff development or inservice activities?

Colleagues, departmental decisions?

Students?

Administrators?

Parents of the students?

Graduation requirements?

15. What new courses, if any, were added in the last 5 years to meet state or district requirements? (Specific courses and number of sections added)
HIGH

16. Were any courses deleted as a result of these changes? (specific courses and number of sections)
HIGH

17. Has the addition of basic level courses led to changes in higher level courses? If so, describe these changes.
HIGH

18. Have changes in curriculum and standards affected teacher assignments to classes?

19. Have changes in curriculum and standards led to differences in student movement from track to track?

20. Have changes in policy influenced science and math instruction at your school?

21. Have added science and math requirements at your school influenced student achievement or interest in these subject areas? If yes, how?

Probes:

More electives in math and science?

Participation in science/math activities?

Test taking patterns or scores on the SAT/ACT?

On state or district-level tests?

22. Have vocational education classes changed in the last three to five years to respond to math and science graduation requirements?

23. What individual would know most about changes in math and science curriculum since 1980?

(NOTE: OBTAIN A COPY OF AN OLD MASTER SCHEDULE, IF POSSIBLE.)

DISTRICT LEVEL INTERVIEWS

ASSISTANT SUPERINTENDENT OF CURRICULUM INTERVIEW PROTOCOL*[1]

[Introduction: I am part of a research team from the University of Wisconsin-Madison. We are doing a study of how recent policies to reform education have influenced math and science in your district and schools. I'd like to ask you some questions about ways these changes have affected ______________(district) and ______________(schools, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?]

1. Tell me about your responsibilities as an assistant superintendent of curriculum, especially with respect to science and math?

2. How long have you held this position?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

3. How long have you been in this district?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

4. What different positions have you held?

LOW

5. Math and science education is getting a lot of attention in the national media, professional associations, and from politicians recently. Have these concerns influenced math and science instruction in this district?

6. In your district, how are decisions about the math and science curriculum made?

HIGH

   a. Are the schools provided with state-level frameworks; district-level frameworks or courses of study?

   b. Are the teachers provided with curriculum guides? If so, by whom were these developed?

---

[1] Researcher: Use of "High," "Medium" or "Low" in left hand margin indicates question priority. If time is limited, be certain to include "high" questions.

c. Who decides what textbooks will be used?

d. Is the selection related to the state framework?

e. Is the selection related to the district framework?

f. Do the district frameworks/course of studies influence district-administered tests?

Researcher's use only:

1 2 3 4 5

No Influence Great Influence

7. Is there a required testing program in this district? If yes, please describe.

Probes:

Tests administered?

Use of tests?

Link to curriculum guides, frameworks or texts?

8. Recently, there have been reports that there are shortages of math and science teachers throughout the country. Is this a problem in this district? **(If not, go on to Question 2).**

If yes:

a. What is being done to alleviate shortages?

b. What factors should be considered when students are placed in math and science courses?

c. What are the barriers to considering these factors?

9. What types of training programs are provided by the individual schools or by the district for teachers to improve their knowledge of the content of science or math or of teaching techniques in these subject areas?

MED

Probes:

What is the content of the programs?

How often are these programs offered?

Are the programs voluntary or mandatory?

What percentage of teachers participate in such programs?

Researcher's use only:

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

10. Over the last four or five years, have there been any changes in district and state curriculum policies in the area of math/science education? If yes, please describe.

HIGH

Changing graduation requirements?

Changing college entrance requirements?

Changing state or local curriculum policies or curriculum guidelines?

New testing policies?

11. In what ways, if any, have these changes affected teachers in this district?

HIGH

Probes:

Changed what is taught? Affected pedagogy?

12. Specifically, what has the greatest effect on teaching strategies? **(e.g., graduation requirements, college entrance requirements, curriculum policies, testing policies, etc).**

13. In what ways, if any, have changes affected teacher assignments to classes?

HIGH

14. Has the addition of basic level courses led to changes in higher level courses? If so, describe these changes.

HIGH

Researcher's use only:

1	2	3	4	5
No change				Much change

15. Have state or district changes led to:
HIGH

__Probes__:

the types of courses offered in math and science in your district?

increases or decreases in the number of sections offered in different classes?

changes in the qualifications of those teaching certain courses?

changes in student assignment or grouping practices?

If yes, please describe.

16. What difficulties, if any, has your district encountered in implementing any of the new policies?
HIGH

17. Have additional math and science requirements in the district influenced student achievement or interest in these subject areas?

__Probes__:

Are students taking more electives in math and science?

Are students showing more interest in math and science club or other math and science-related activities?

Have there been any changes in test taking patterns or scores on the SAT/ACT?

Have there been any changes in test taking patterns or scores on the state or district-level tests?

18. In your view, what are this district's biggest challenges in implementing good math and science education?

(NOTE: ONLY COMPLETE THIS SECTION IF A MATH/SCIENCE CURRICULUM SPECIALIST IS NOT INTERVIEWED IN THIS DISTRICT).

19. Describe the overall science and the math curricula in this district. **(Collect available documents).**

MATH/SCIENCE CURRICULUM SPECIALIST INTERVIEW PROTOCOL*[1]

[Introduction: I am part of a research team from the University of Wisconsin-Madison. We are doing a study of how recent policies to reform education have influenced math and science in your district and schools. I'd like to ask you some questions about ways these changes have affected _____________(district) and _______________(schools, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?

Any information you provide will be available only to our research team an no one in your district or school will know what you say. Because I can't record your ideas fast enough with pencil and paper, I'd like to record our conversation, but won't do that unless you agree. Is it okay?]

1. Tell me about your responsibilities as a curriculum specialist.

2. How long have you held this position?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

3. How long have you been in this district?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

4. What different positions have you held?

5. Describe the overall science/math curriculum in this district. **(Collect available documents).**

HIGH

6. Do you feel the math/science teachers in this district have the subject matter background and training necessary to teach their classes? Why or why not?

---

[1] Researcher: Use of "High," "Medium" or "Low" in left hand margin indicates question priority. If time is limited, be certain to include "high" questions.

HIGH

7. Recently, there have been reports that there are shortages of math/science teachers throughout the country. Is this a problem in this district? **(If not, go on to Question 8).**

HIGH

Probes:

a. What is being done to alleviate shortages?

b. Are these steps sufficient? If not, what further steps would you like to see taken?

8. What types of training programs are provided by the individual schools or by the district for teachers to improve their knowledge of the content or teaching techniques?

Probes:

a. How often are these programs offered?

Researcher's use only:

1	2	3	4	5
None	Annually	Once a semester	Monthly	Continuously

b. Are the programs voluntary or mandatory?

c. What percentage of teachers participated in such programs last semester?

Researcher's use only:

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

9. In your district, how are decisions about the math and science curriculum made?

HIGH

Probes:

State-level frameworks?

District-level frameworks or courses of study?

Curriculum guides? If so, by who were these developed?

10. Who decides what textbooks will be used?

a. Is selection related to state framework?

b. Is selection related to district framework?

11. Does the district provide frameworks/course of studies?

a. If yes, do they influence district-administered tests? If yes, how?

Researcher's use only:

1	2	3	4	5
None	Minimal Influence	Moderate Influence	Heavy Influence	State Determined

b. Do district, state, or national tests influence district frameworks/courses of study?

Researcher's use only:

District

1	2	3	4	5
None	Minimal Influence	Moderate Influence	Heavy Influence	State Determined

State

1	2	3	4	5
None	Minimal Influence	Moderate Influence	Heavy Influence	State Determined

National

1	2	3	4	5
None	Minimal Influence	Moderate Influence	Heavy Influence	State Determined

12. Math and science education is getting a lot of attention in the national media, professional associations, and from politicians recently. Have these conversations influenced math and science instruction in this district?

13. Do school administrators support math and science instruction at individual schools?

a. If yes, how?

b. What about district-level administrators?

14. Over the last four or five years, have there been any changes in district and state policies in the area of math/science education?

HIGH

a. If yes, has your job changed as a result of these changes?

MED

b. In what ways, if any, have teachers been affected in this district?

HIGH

Probes:

Content?

Strategies?

c. Have there been changes in the methods used to assign teachers to classes?

d. What policy changes have had the greatest effect upon math/science education?

HIGH

Probes:

Graduation requirements?

College entrance requirements

Curriculum policies

Testing policies

e. What classes were added or deleted as a result of these changes in these policies?

Probes:

Graduation requirements?

College entrance requirements?

State or local curriculum policies, such as new textbooks or curriculum guidelines?

Testing policies?

15. Has the addition of basic level courses had any effects on higher level courses? If so, describe these changes.

16. Have changes required by the SDE or the district affected the following:

HIGH

increases or decreases in the number of sections offered in different classes?

changes in the qualifications of those teaching certain courses?

changes in student assignment or grouping practices?

changes in what is taught in higher level courses?

changes in how teachers present material in higher level courses?

(ONLY COMPLETE THIS QUESTION IF A DIRECTOR OF TESTING IS NOT INTERVIEWED IN THIS DISTRICT)

17. Have added math/science requirements in the district influenced student achievement or interest in these subject areas?

a. Are students taking more electives in math/science?

b. Are students showing more interest in math/science club or other math/science-related activities?

c. Have there been any changes in test taking patterns or scores on the SAT/ACT?

DIRECTOR OF TESTING INTERVIEW PROTOCOL*[1]

[Introduction: I am part of a research team from the University of Wisconsin-Madison. We are doing a study of how recent policies to reform education have influenced math and science in your district and schools. I'd like to ask you some questions about ways these changes have affected ______________(district) and ______________(schools, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?

Any information you provide will be available only to our research team an no one in your district or school will know what you say. Because I can't record your ideas fast enough with pencil and paper, I'd like to record our conversation, but won't do that unless you agree. Is it okay?]

1. Tell me a little about your role as Director of Testing with regard to science and math.

Probes:

Responsibilities?

Amount of time spent on science testing?

2. How long have you held this position?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

3. How long have you been in this district?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

4. What different positions have you held?

---

[1] Researcher: Use of "High," "Medium" or "Low" in left hand margin indicates question priority. If time is limited, be certain to include "high" questions.

5. Describe the district's testing program in regard to science and math.
HIGH

Probes:

Standardized tests?

Minimum competency testing?

a. If yes, who develops these tests?

b. How are decisions made regarding what constitutes "minimum competence?"

c. How often are these tests revised? Why?

d. What is the role of teacher-developed tests in this district?

6. Does standardized testing have an influence on student placement in science and math courses?
HIGH

Researcher's use only:

1	2	3	4	5
None	Little	Only 1 of several considerations	Weighs heavily	Determines placement

7. What influence, if any does competency testing have on student placement in science and math courses?
HIGH

Researcher's use only:

1	2	3	4	5
None	Little	Only 1 of several considerations	Weighs heavily	Determines placement

8. What influence, if any, does the testing program in this district have on course offerings?
HIGH

Researcher's use only:

1	2	3	4	5
None	Minimal	1 of several influences	Major influence	Determines courses

9. What influence, if any, does the testing program in this district have on course content?
HIGH

Researcher's use only:

1	2	3	4	5
None	Minimal	1 of several influences	Major influence	Determines courses

Probes:

Connection to the district level framework?

Influence on school-level offerings?

10. What influence, if any, does the testing program in this district have on teachers' instructional practices?

MED

Researcher's use only:

1	2	3	4	5
None	Minimal	1 of several	Major influence	Determines strategies

Probes:

Content selection?

1	2	3	4	5
None	Minimal	1 of several	Major influence	Determines strategies

Pencil/paper testing?

1	2	3	4	5
None	Minimal	1 of several	Major influence	Determines strategies

Teaching testing skills?

1	2	3	4	5
None	Minimal	1 of several	Major influence	Determines strategies

11. What role, if any, do state level administrators play in making decisions about testing?

Researcher's use only:

1	2	3	4	5
None	Minimal	1 of several	Major influence	Sole determinant

12. Math and science education is getting a lot of attention in the national media from professional associations, and from politicians recently. Have these conversations influenced testing and/or test development in this district? If yes, why do you think so?

HIGH

13. Over the last four or five years, have there been any changes in district and state policies in the area of math/science education?

LOW

14. Has your job changed as a result of these changes in policy?

15. Have there been any changes in test-taking patterns or scores on the SAT/ACT in the schools targeted by our study?

HIGH

16. Have there been any changes in test-taking patterns or scores on a state or district-level tests in the schools targeted by our study?

HIGH

17. Have added math and science requirements or other policy changes in the district influenced student achievement as reflected in district test scores (including district and state tests)?

HIGH

18. In the best of worlds, is there anything you would change about your district's testing program? If so, what is preventing this from occurring presently?

MED

STATE MATH OR SCIENCE COORDINATOR OF CURRICULUM INTERVIEW PROTOCOL*

[Introduction: I am part of a research team from Stanford University. We are conducting a study of how recent policies to reform education have influenced math and science in your state. I'd like to ask you some questions about ways these changes have affected __________(state) and ______ (districts, if appropriate). The questions are largely in four categories: What is taught? Who teaches it? To whom is it taught? What are the effects?]

1. Please give me a brief overview of your responsibilities as the state __(title)__, with respect to science and math?

2. How long have you held this position?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

3. How long have you worked for the state dept. of education (or appropriate unit)?

Researcher's use only:

1	2	3	4	5
0-2yrs	3-5yrs	5-7yrs	7-9yrs	10+yrs

4. What different positions have you held?

5. What is the state's overall strategy for improving math and science education?

    a. Math and science education is getting a lot of attention in the national media, professional associations, and from politicians recently. Have these concerns influenced math and science instruction in this state?

6. Does [______ state] provide districts with state-level frameworks or courses of study?

    a. How specific are these frameworks regarding the content to be covered and the order of topics? Do you have detailed curriculum guides that you provide to districts? (If so, by whom were these guides developed?).

b. Does the state require districts to follow these frameworks? If so, what is done to monitor or evaluate district performance in this area?

c. Do the state frameworks/courses of study influence district-administered tests?

d. How long has the state used frameworks in this way? In what ways does this differ from how frameworks were previously used?

(GET COPIES OF FRAMEWORKS AND/OR CURRICULUM GUIDES)

7. Who decides what textbooks will be used?

a. Please describe the process by which textbooks are chosen. (Probe for the degree of latitude given to districts to control textbook selection).

b. Is the selection of textbooks related to state curriculum frameworks?

8. Is there a required testing program in this state? If yes, please describe.
Probes:
Any recent changes?
Characterize the content and difficulty of the test.
Tests administered?
Use of tests?
Link to curriculum guides, frameworks or texts?

(GET COPIES OF TEST)

9. Recently, there have been reports that there are shortages of math and science teachers throughout the country. Is this a problem in this state? **(If not, go on to Question 10).**

If yes:
a. What is being done to alleviate shortages?

b. What are the barriers to considering these solutions?

10. What types of training programs are provided by the state for teachers to improve their knowledge of subject content, teaching techniques, or to promote the state frameworks?

Probes:

What is the content of the programs?
How often are these programs offered?
Are the programs voluntary or mandatory?
What are the sources for funding for these programs?
What percentage of teachers participate in such programs?
How recently were these policies revised?
How do they differ from what came before?

11. Over the last four or five years, have there been any changes in state policies regarding graduation or college entrance requirements in the areas of math and/or science? If yes, please describe.

12. In what ways, if any, have these changes affected teachers in this state?

Probes:

Changed what is taught? Affected pedagogy?

13. Specifically, what is the relative impact of graduation requirements, college entrance requirements, curriculum policies, testing policies, or other considerations on course content and teacher pedagogy in (math and/or science).

14. In what ways, if any, have changes affected teacher assignments to classes?

15. Have course offerings changed in any way as a result of recent changes? If so, describe these changes.

Probes:

Have student course-taking patterns changed?

Any increases or decreases in the number of sections offered in different classes?

Any changes in the qualifications of those teaching certain courses?

Any changes in student assignment or grouping practices?

Researcher's use only:

1	2	3	4	5
No change				Much change

16. What difficulties, if any, has your state encountered in implementing any of the new policies?

17. Have additional math and science requirements in the state influenced student achievement or interest in these subject areas?

Probes:

Are students taking more electives in math and science?

Are students showing more interest in math and science club or other math and science-related activities?

Have there been any changes in test taking patterns or scores on the SAT/ACT?

Have there been any changes in test taking patterns or scores on the state or district-level tests?

18. In your view, what are this state's biggest challenges in implementing good math and science education?

19. Do you see any gaps in state policies or conflicts between different state policies affecting curriculum and pedagogy in (math/science)? If so, what is the nature of the gaps or conflicts?

20. What strategies do teachers use to resolve those conflicts in their own classrooms?

21. How deep is the impact of state policies on (math/science) teachers? What would you estimate is the percentage of teachers that have been substantially impacted by state policies per se?

22. Is the state considering new policies or major changes in existing policies regarding math/science education at this time? If yes, briefly describe the nature of the changes being considered.

(Collect available documents - state frameworks, tests, model curriculum guides, etc.)

APPENDIX B

REFORM UP CLOSE
ADVISORY COMMITTEE MEMBERS AND CONSULTANTS

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Reform Up Close
Advisory Committee Members and Consultants

Members

Gail Burrill
Science Teacher
Hales Corners, WI

Rolf Blank
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APPENDIX C

SCALE DEFINITIONS, ITEM MEANS AND STANDARD DEVIATIONS

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Scale Definitions, Item Means and Standard Deviations

Policy Variables

Policy--Policy ($\alpha = .48$)

46) The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does each of the following have?
(3 point scale; 1 = positive influence, 0 = no influence, -1 = negative influence)

		$\bar{X}$	S	N
T)	District testing	-.04	.73	291
U)	Graduation requirements	.63	.65	293

79) Rate how big an influence (major influence to no influence) each factor below has in determining the content (information, concepts, skills) of your science course.
(4 point scale; 3 = major influence, 0 = no influence)

A)	State curriculum guides	1.94	1.03	304
B)	District curriculum guides	2.33	.91	305
E)	District tests	1.51	1.21	301
F)	State tests	1.39	1.13	299

82) Within the last three years, which of the following occurred at your school?
(2 point scale; 1 = yes, 0 = no or don't know)

E)	Increased graduation requirements in English, mathematics, science, social studies, computer science, or foreign languages	.58	.49	296
F)	Implemented competency testing for promotion or graduation	.30	.46	296

Control Variables

School Ability--Schabil ($\alpha = .36$)

42) How would you rate the average academic ability of students when they enter this school? (inverted)
(5 point scale; 2 = much above national norm, -2 = much below national norm)

	-.97	.82	297

46I) The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does each of the following have

	$\bar{X}$	S	N
Student reading abilities (3 point scale; 1 = positive influence, 0 = no influence, -1 = negative influence)	-.39	.86	292

School Behavior--SCB (α = .87)

44) Indicate the degree to which each of the following matters are a problem with students in your school.

(4 point scale; 3 = not a problem; 0 = serious problem)

A)	Tardiness	1.13	.94	307
B)	Absenteeism	.64	.79	306
C)	Class cutting	1.16	.91	306
D)	Physical conflicts among students	1.69	.81	307
E)	Gang activities	1.97	.86	306
F)	Robbery or theft	1.80	.81	307
G)	Vandalism	1.68	.84	307
H)	Use of alcohol	1.52	.89	304
I)	Use of other drugs	1.41	.81	304

46) The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does each of the following have?

(3 point scale; 1 = positive influence, 0 = no influence, -1 = negative influence)

L)	Student attendance	-.22	.93	305
P)	Student discipline	-.13	.92	305

Class Ability--Clqabil ($\alpha = .62$)

50) How would you describe this class in terms of variation in student ability? (Circle one.)

		$\bar{X}$	S	N
fairly homogeneous and low in ability	1			
fairly homogeneous and average in ability	2			
fairly homogeneous and high in ability	3	2.00	.55	303
heterogeneous with a mixture of two or more ability levels (4 rescaled as 2)	4			

52) Estimate the number of students who are repeating the course (100 minus percent of class repeating) .92 .13 276

53) Given the preparation and ability of students in this class, how would you characterize the overall level of student effort? (inverted)
(3 point scale; 1 = above expectation, -1 = below expectation) -.23 .60 307

72) What do you estimate will be the approximate distribution of final student grades in this class?
(Total = 100%) (Enter percentage for A through F; GPA calculated.)
GPA = 2.11 .66 304

School Climate Variables

Leadership--Ldrshp ($\alpha = .63$)

19) In this school the mathematics/science curriculum is well-coordinated.
(6 point scale; 1 = strongly disagree, 6 = strongly agree) 3.29 1.54 294

27) The principal talks with me frequently about my instructional practices.
(6 point scale; 1 = strongly disagree, 6 = strongly agree) 2.64 1.45 296

29) The principal knows what kind of school he/she wants and has communicated it to the staff.
(6 point scale; 1 = strongly disagree, 6 = strongly agree) $\bar{X}$ S N

4.33 1.41 296

46Q) The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does articulation of instruction across grade levels have?
(3 point scale; 1 = positive influence, 0 = no influence, -1 = negative influence)
.26 .80 291

Resources--Resrc ($\alpha = .78$)

26) Necessary materials (e.g., textbooks, supplies, copy machine) are available as needed by the staff.
(6 point scale; 1 = strongly disagree, 6 = strongly agree) 3.75 1.55 294

31) Instructional resources at this school are inadequate for my needs.
(6 point scale; 0 = strongly disagree, 5 = strongly agree) 2.88 1.51 293

46) The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does each of the following have?
(3 point scale; 1 = positive influence, 0 = no influence, -1 = negative influence)

B)	Facilities	.16	.89	291
C)	Funds for purchasing equipment and supplies	.15	.91	292
D)	Materials for individualizing instruction	.14	.80	286
E)	Number of textbooks	.44	.82	293
G)	Access to computers	.14	.85	292

58) Which best describes the availability of computers (microcomputers or terminals to mini/mainframe) for use with this class?
(3 point scale; 3 = readily available, 1 = not available)

A)	Teacher demonstrations	1.85	.80	300
B)	Student use in classrooms	1.50	.71	301
C)	Student use in labs	1.88	.77	302

Institutional Support–Insup ($\alpha = .59$)

23) The school administration's behavior toward the staff is supportive and encouraging.
(6 point scale; 1 = strongly disagree, 6 = strongly agree) 4.36 1.34 307

46) The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does each of the following have?
(3 point scale; 1 = positive influence, 0 = no influence, -1 = negative influence)

		$\bar{X}$	S	N
M)	Teacher planning time	.37	.84	303
N)	Time to teach mathematics/science	.51	.73	303
O)	Class sizes	-.08	.94	306
V)	Counselors	.33	.79	304

Shared Beliefs--Shbelf (α = .44)

28) Most of my colleagues share my beliefs and values about what the central mission of the school should be.

(6 point scale; 1 = strongly disagree, 6 = strongly agree)	3.98	1.16	295

46) The following factors may affect mathematics/science instruction in your school as a whole. In your opinion, what type of influence does each of the following have?
(3 point scale; 1 = positive influence, 0 = no influence, -1 = negative influence)

A)	Belief in the importance of mathematics/science when compared to other subject areas	.57	.65	292
J)	Teacher interest in mathematics/science	.82	.48	295

Teacher Control--Tcntrl (α = .56)

12) Staff are involved in making decisions about what will be taught in their courses.

(6 point scale; 1 = strongly disagree, 6 = strongly agree)	4.13	1.51	292

32) At this school, how much actual influence do you think teachers have over the following?
(6 point scale; 1 = none, 6 = complete control)

B)	Setting policy on grouping students in classes by ability	2.63	1.38	293
C)	Establishing curriculum	3.35	1.36	293
D)	Deciding what students should take what courses	2.95	1.40	293

33) How much control do you feel you have in your classroom over each of the following areas in your planning and teaching?

	(6 point scale; 1 = none, 6 = complete control)	$\bar{X}$	S	N
A)	Selecting textbooks and other instructional materials	3.50	1.55	292
B)	Selecting content, topics, and skills to be taught	4.09	1.45	293
C)	Selecting teaching techniques	5.40	.81	293
D)	Determining the amount of homework to be assigned	5.52	.76	294
E)	Setting standards for achievement in my classes	5.38	.87	294

79) Rate how big an influence each factor below has in determining the content of your mathematics/science course.

(4 point scale; 1 = major influence, 4 = no influence)

C)	Departmental decisions and guidelines	2.02	.92	301
D)	The main course textbook	1.83	.96	303
G)	Department-wide tests	2.94	1.14	298

Individual decisions (4 point scale; 3 = major influence, 0 = no influence)

H)	My own beliefs about what topics are important	1.62	.75	304
I)	My own knowledge of particular topics	1.69	.95	304
J)	What my students are capable of understanding	1.61	.78	305
K)	What my students need for future study and work	1.50	.71	303

Administrators (1 = major influence, 4 = no influence)

L)	A principal or assistant principal	3.06	.95	303
M)	District curriculum specialist	2.81	1.02	298

Teacher Climate Variables

Level and Amount of Education--Educ (α = .44)

5) The sum of the following: 2 points for every college degree (bachelors and beyond) for which the major was in a field relevant to the teaching assignment and 1 point for any degree with a minor in a field relevant to the teaching assignment. 2.18 1.56 297

7) One point for every certification relevant to the teaching assignment. 1.25 .85 297

9) Please indicate below the number of quarter or semester courses you have taken at the undergraduate and graduate levels in the fields specified. Please refer to your college transcripts if accessible. Estimate if you must.

(6 point scale; 1 = 0 to 1 courses, 6 = 10 or more courses)

For math teachers,

A)	Mathematics	2.94	2.90	297
B)	Mathematics education	1.59	2.07	297

	X̄	S	N
For science teachers,			
E) Science	2.66	2.93	297
F) Science education	1.59	2.25	297
Load--Load (α = .49)			
39) During regular school hours, about how many hours per week do you have free for lesson planning and class preparation? (Enter hours per week in space provided.) (inverted)	5.59	3.09	294
40) How many hours per week are you assigned to teach? (Enter hours per week in blank space provided.)	21.93	6.90	294
41) What is the total number of students you teach per day? (Enter number of students in blank provided.)	122.39	35.46	294
Teacher Responsibility--Tresp (α = .57)			
13) My success or failure in teaching students is due primarily to factors beyond my control rather than to my own effort and ability. (6 point scale; 0 = strongly agree, 5 = strongly disagree)	2.66	1.59	294
14) I sometimes feel it is a waste of time to try to do my best as a teacher. (6 point scale; 0 = strongly agree, 5 = strongly disagree)	3.95	1.37	296
16) Teachers are not a very powerful influence on student achievement when all factors are considered. (6 point scale; 0 = strongly agree, 5 = strongly disagree)	3.68	1.27	296
Collegiality--Colsc (α = .55)			
17) I am familiar with the content and specific goals of the courses taught by other teachers in my department. (6 point scale; 1 = strongly disagree, 6 = strongly agree)	4.24	1.29	294
18) I make a conscious effort to coordinate the content of my courses with other teachers. (6 point scale; 1 = strongly disagree, 6 = strongly agree)	4.16	1.34	295
30) There is a great deal of cooperative effort among staff members. (6 point scale; 1 = strongly disagree, 6 = strongly agree)	4.10	1.24	295

		X̄	S	N
37)	Since the beginning of this school year, how much time per month (on average) have you spent meeting informally with other teachers on lesson planning, curriculum development, or other instructional matters? (6 point scale; 1 = < 15 minutes, 6 ≥ 10 hours)	3.66	1.54	295

Teacher Satisfaction--Tsat (α = .56)

15)	I usually look forward to each working day at this school. (6 point scale; 1 = strongly disagree, 6 = strongly agree)	4.64	1.25	292
20)	Staff members in this school generally don't have much school spirit. (6 point scale; 5 = strongly disagree, 0 = strongly agree)	2.93	1.37	295
34)	How much of the time do you feel satisfied with your job in this school? (4 point scale; 0 = almost never, 3 = all of the time)	1.86	.61	296

Dependent Variables

Change--Chng (α = .63)

80) Within the last three years, what changes have occurred in this course? (1 = Yes; O = No)

C)	Using different textbooks	.47	.50	288
D)	Using different teaching methods	.59	.49	286
		X̄	S	N
E)	Revised course content to less difficult level	.32	.47	284
F)	Revised course content to more difficult level	.23	.42	283
G)	Altered sequence of topics	.55	.50	285

81) Using the scale provided, to what extent have the following changed during the last three years:
(4 point scale; 0 = no change, 3 = big positive or negative change)

A)	The amount of time devoted to nonteaching school activities or duties	1.40	1.07	295
B)	Agreement among professional staff on school goals	.98	.93	296
C)	Your professional relationship with your principal or school head	1.05	1.01	296

82) Within the last three years, which of the following occurred at your school?
(3 point scale; 1 = Yes, 0 = Don't know, -1 = No)

A)	Lengthening the school day	-.59	.76	303
B)	Lengthening the school year	-.65	.70	302
C)	Establishing a policy of increased homework	-.50	.82	303
D)	Increased the number of advanced course offerings	.01	.93	303
G)	Established new consistently enforced codes of student conduct	-.31	.90	302
H)	Established a stricter attendance policy	-.19	.95	303
I)	Established grade requirements for participation in athletics or extracurricular activities	.31	.90	302

Pedagogy

Teacher Demands on Students–Tdsp (α = .60)

22) The teachers in this school push the students pretty hard in their academic subjects. (6 point scale; 1 = strongly disagree, 6 = strongly agree)	3.83	1.32	299
67) How much homework do you assign this class in a typical week? (6 point scale; 1 = 0-30 minutes, 6 = more than 3 hours)	3.54	1.51	311
68) How often do you keep a record of who turned in homework assignments? (4 point scale; 1 = never, 4 = all of the time)	3.73	.65	312
69) How often do you return assignments with grades or corrections? (4 point scale; 1 = never, 4 = all of the time)	3.20	1.00	309
70) How often do you discuss assignments in class? (4 point scale; 1 = never, 4 = all of the time)	3.44	.74	312
71) How often do you include homework grades when computing course grades? (4 point scale; 1 = never, 4 = all of the time)	3.84	.55	308
73F) Indicate the importance you give to completing homework assignments in setting grades for students in this class. (4 point scale; 1 = not important, 4 = extremely important)	3.18	.74	311

Active Learning--Aclrng ($\alpha = .58$)

54) About how much classroom time do you spend on each of the following with this class during a typical week?

(5 point scale; 1 = none to 5 = 3 or more hours)		$\bar{X}$	S	N
A)	Lecturing to the class (5 point scale; 0 = 3 or more hours, 4 = none)	1.78	1.00	308
C)	Whole class discussion	2.48	.88	299
D)	Students working in pairs/teams/small groups	2.73	1.15	298

55) How much classroom time do students spend on each of the following activities for this class during a typical week?

(5 point scale; 1 = none to 5 = 3 or more hours)

A)	Listening/taking notes (4 = none, 0 = 3 or more hours)	1.65	.96	311
B)	Engaged in discussion	2.78	.93	306
D)	Writing a report/paper	1.52	.83	268
E)	Doing lab or field work	2.13	1.26	281

57C) Importance of observation, measurement, ordering, comparing, classifying in this class. (inverted)

(5 point scale; 4 = most important, 0 = least important)	1.79	1.22	310

57E) Importance of interpreting data, recognizing patterns, designing experiments in this class. (inverted)

(5 point scale; 4 = most important, 0 = least important)	1.71	1.31	309

Content

Higher Order Thinking--HOT ($\alpha = .57$)

74) Pairs of statements representing opposite ends of a continuum in curriculum approaches. Circle a position on the continuum that indicates where you would put your approach.

A)	36 point continuum:	18.51	8.13	311

1 = My primary goal is to help students learn mathematical/scientific terms, formulae, master computational and laboratory skills, and solve word problems.

36 = My primary goal is to help students achieve a deeper (conceptual) understanding of math/science.

		$\bar{X}$	S	N
B)	36 point continuum:	16.58	9.24	310
	35 = In my math/science course, I am for indepth study of selected topics and issues, even if it means sacrificing coverage.			
	0 = In my math/science course, I am for comprehensive coverage, even if it means sacrificing indepth study.			
C)	36 point continuum:	20.99	9.42	306
	1 = My students generally learn basic facts/skills/formulas before learning underlying principles.			
	36 = My students generally learn basic facts/skills/formulas while learning underlying principles.			
75)	In your math/science class, how much do you currently emphasize each of the following objectives: (4 point scale; 1 = none, 4 = heavy emphasis)			
D)	Develop problem solving/inquiry skills	3.34	.67	309
G)	Teach applications of mathematics in science	2.50	.84	311
H)	Teach applications of math/science in business and industry	2.57	.83	310
77)	Some education reports recommend that in math/science courses, students spend much more time learning the underlying logic of math/science, working on open-ended and real-world problems and examining the reasoning behind certain mathematical/scientific rules/procedures. Compared with the way most courses are now, this recommendation could significantly reduce the number of different topics a course could cover and reduce emphasis on routine computations. Do you think this would be a better or worse way to teach mathematics/science in your class? (5 point scale; 0 = definitely worse, 4 = definitely better)	2.23	1.19	309